IWR White Paper

June 2010

Scenario-Based Strategic Planning in the U.S. Army Corps of Engineers Civil Works Program

US Army Corps of Engineers®

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The purpose of this paper is to document and critique a scenario-based strategic planning initiative that was undertaken by the USACE Civil Works Program from 2006 to 2007. Scenario planning is a technique designed to help organizations develop strategies that are robust, i.e. effective in a wide range of future conditions.

The objectives of USACE's scenario-based strategic planning exercise were twofold: 1) to foster strategic thinking in the organization; and 2) to produce a strategic plan that accounts for future uncertainties. While the Strategic Plan was intended to cover a five-year period, the scenario planning effort adopted a 30-year time horizon to develop strategies and actions which would prepare the organization for long-term success.

This paper will introduce and discuss scenario analysis in general, describe the specific approach used by USACE, and then provide details of the process and products generated at each step. It will conclude with an evaluation of the effort, and recommendations for future scenario-based strategic planning in USACE.

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Scenario-Based Strategic Planning in the U.S. Army Corps of Engineers Civil Works Program

Anne Cann
Institute for Water Resources

US Army Corps of Engineers®

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"The Corps needs to shape its future proactively and adaptively, and anticipate the unforeseen, rather than just reacting, within a highly uncertain environment."
Major General Don T. Riley, U.S. Army Corps of Engineers

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Scenario based strategic planning in the USACE Civil Works Program was a team effort, and dozens of individuals participated in the process and contributed both directly and indirectly to the content of this report. Major contributors include the Strategic Planning Project Delivery Team (PDT), which was led by Ada Benavides. Members of the PDT included Donna Ayres, Anne Cann, Norm Starler, Erik Nelson, Mona Thomason, Julie Marcy, Carl Borash, Glenda Ashford, Donald Groh, Dimitra Syriopoulou, Scott Nicholson, Kimberly Barnett, and Will Rogers. Major General Don T. Riley, while serving as Director of Civil Works, championed the effort and participated at all stages. Other contributors include Robert Pietrowsky, Ken Lichtman, Anil Patel, Michael Kingsley, and Bruce Elliott. In addition, a contractor was employed to assist and support the scenario based strategic planning initiative, Decision Strategies International, Inc. (DSI) Michael Mavaddat and Martin Reuss of DSI participated fully in all workshops and prepared initial drafts of the uncertainty descriptions. Martin Reuss was the principal author of the scenarios.

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Introduction

The purpose of this paper is to document and critique a scenario-based strategic planning initiative that was undertaken by the USACE Civil Works Program from 2006 to 2007. Scenario planning is a technique designed to help organizations develop strategies that are robust, i.e. effective in a wide range of future conditions.

The objectives of USACE's scenario-based strategic planning exercise, as laid out by Senior Leaders, were twofold: 1) to foster strategic thinking in the organization; and 2) to produce a strategic plan that accounts for future uncertainties. Although each Civil Works Strategic Plan covers a five year period, the scenario planning effort adopted a 30 year time horizon, looking out to 2035, to develop strategies and actions which would prepare the organization for long term success. In other words, a five year strategy was developed in the context of a 30 year vision.

The strategic planning effort was organized as follows. A Project Delivery Team (PDT) was led by the Project Manager, and was composed of interdisciplinary members from: 1) across the CW organization (Civil Works Headquarters, the Institute for Water Resources, and Regional representatives); 2) USACE corporate leadership (Military Programs, Research and Development, and the Strategic Integration Directorate); and beyond USACE (Office of the Assistant Secretary of the Army for Civil Works, and Office of Management and Budget). The effort was overseen and guided by an Executive Steering Committee, led by the Director of Civil Works, consisting of HQ Civil Works Senior Leaders. The Executive Steering Committee provided direction to the effort, reviewed and validated products throughout the process. Workshop sessions were held sequentially, at each stage of the process. Typically the PDT would hold a workshop, develop a draft product, and then a Senior Leader workshop would be held to engage them in discussions, obtain their input and approval of the interim products. A consultant, Decision Strategies, Inc., provided initial training for PDT members, drafted the scenarios, and participated/supported all of the workshops.

This paper will introduce and discuss scenario analysis in general, describe the specific approach used by USACE, and then provide details of the process and products generated at each step. It will conclude with an evaluation of the effort, and recommendations for future scenario-based strategic planning in USACE.

Background on Scenario Planning

Scenario planning is a mixture of art and science, requiring creativity and imagination as well as technical knowledge and analytical skills. Although the focus is often on the scenarios themselves, the *raison d'être* of this planning technique is insights that can guide the formation of robust strategies.

Scenarios are divergent stories about the future. The story format allows people and organizations to envision possible future consequences of complex interactions among economic, political, social, and environmental forces. Scenarios are not predictions of the future, and in most cases the scenarios are not likely to occur exactly as written, but they do need to be plausible. They describe events which could happen, which might happen. They are designed to take an outside-in focus, beginning with external forces and ending with internal actions that the organization might take to prepare for and cope with the eventualities depicted in the scenarios. The idea is to focus on the issues most relevant to the missions of the organization. For USACE Civil Works, the main focus was water resources.

Scenario planning was first used by the military in the Cold War years as a way of considering what might happen in the event of nuclear war. In the late 1960's, Royal Dutch Shell further developed and popularized the approach, effectively employing it to deal with the uncertainty of oil prices and other shocks to the corporate world. So although scenario planning as a discipline is nearly half a century old, its relevance is newly affirmed by the growing need to make significant decisions in the face of large uncertainties.

Increasingly, scenario analysis is being used by corporations, governments, and other organizations to help in the development of strategic plans. The technique is a creative, flexible way of developing strategies for an uncertain future. Scenarios can be used to better understand how events unfolding in the world, which are often beyond the control of an organization, may lead to problems, risks, and opportunities.

The National Intelligence Council used scenarios in its recent Global Trends report (National Intelligence Council 2008). An insight emerging from their analysis is that water may become a transnational issue, along with food and energy.

The U.S. Coast Guard is using scenarios to guide the thinking behind its process of strategy development and strategic renewal. The effort is called Evergreen, and the Coast Guard is beginning the third Evergreen cycle, which will run through 2012. New scenarios are prepared and analyzed every four years. The process draws on the knowledge and experience of active duty, reserve, auxiliary, and civilian Coast Guard members, as well as maritime industry stakeholders. Details on their process and copies of the reports are available at http://www.uscg.mil/strategy/documents.asp

Another agency utilizing scenarios in strategic planning is the National Oceanographic and Atmospheric Administration (NOAA). Their scenarios can be accessed at this site http://www.ppi.noaa.gov/PPI_Capabilities/Documents/Scenarios-5-28-09.pdf.

Approach Used by USACE

There is more than one way to develop scenarios and apply them to strategic planning. USACE's scenario-based Strategic Planning process was adapted from the book, "Profiting from Uncertainty" (Shoemaker 2002). It encompassed the following steps:

1. Define the scope – Time frame for the scenarios was defined to be about 30 years into the future, to the year 2035. The boundaries of analysis were generally to focus on water resources in the United States, recognizing that forces in other parts of the world and in other sectors can have a large impact.

2. Evaluate important external factors – 124 external factors were identified, researched, and described that could impact water resources and the mission areas of USACE in the future.

3. Identify trends and uncertainties – the factors were ranked by importance and predictability. Similar factors were clustered together. High importance and high predictability (low uncertainty) were identified as trends. High importance and low predictability (high uncertainty) were identified as uncertainties.

4. Develop scenarios – the two major uncertainties (i.e. those most likely to have major impacts on the missions and activities of the organization) were used to construct a 2 X 2 scenario matrix; other uncertainties as well as trends were woven into storylines for each of the four scenarios.

5. Conduct strategic segmentation analysis - this step involved the identification and analysis of USACE customers into strategic segments, so as to customize strategies for succeeding with each.

6. Define core competencies - these are the strengths and capabilities that the organization possesses today.

7. Define key success factors - these are the capabilities that will be needed in the future to cope in any of the scenarios. They were derived from thinking about the implications of each scenario for USACE's Civil Works Program and what actions and capabilities would be needed to ensure success in alternative futures.

8. Set future direction – this is where USACE's civil works program is heading, how should it change in light of the scenarios and their implications.

9. Strategic Goals and Objectives. The goals and objectives from the 2004 Civil Works Strategic Plan were updated as part of this exercise.

10. Strategies. Cross cutting strategies were designed to build key success factors, apply to all missions and goals, be effective in any scenario, and enable the organization to move from the present toward the desired vision.

External Factors and Forces

USACE began the scenario based planning process by identifying factors, or external forces, which could potentially impact water resources in the U.S. A list of 124 such factors was generated. They covered the gamut outlined by the STEEPS system (social, technological, economic, environment, political, and security). Research was completed and descriptions were prepared for each factor. These are included in Appendix A.

The Strategic Planning Project Delivery Team (PDT) and USACE Senior Leaders were then asked to evaluate the factors with respect to two criteria. The first criterion was importance to water resources. The second was predictability, or inversely, how much unpredictability or uncertainty surrounds the factor. Respondents to the informal survey numbered 18. The survey instructions and results of this survey are also included in Appendix A.

The next step in factor analysis was sorting the results of the survey on the basis of importance and predictability. Factors that were ranked high in both importance and predictability were identified as potential trends. Factors that were ranked high in importance and low in predictability (i.e. high in unpredictability) were considered as potential uncertainties. Factors that ranked low on the importance scale were dropped.

Trends and Uncertainties

At this stage similar and highly correlated factors were clustered together to yield a manageable number of trends (high importance, high predictability), and uncertainties (high importance, low predictability). Discussions and workshops were held among PDT members and Senior Leaders, and these yielded some additional uncertainties.

The key trends or 'relative certainties' which emerged from the analysis are:

- There is continued discovery and application of scientific knowledge.
- There will be a gradual and steady increase in global temperatures.
- U.S. population is increasingly urbanized and concentrated in large megalopolises.
- The increasing and conflicting demands on water supplies will stress the adaptive capacity of individuals and institutions, with the potential to raise water costs.
- Biodiversity is declining; the single greatest threat to species survival is the loss of their habitat.
- World population growth will continue and will be concentrated in developing countries.
- Ever faster and better information and communication technologies will pervade every aspect of society, increasing the reach and influence of stakeholders to promote their agendas.
- There will be continued pressure to balance the Federal budget.

Factors which were both important and unpredictable were consolidated into key uncertainties. They are listed below as questions, posed from the vantage point of the year 2035.

U1. What is the socio-political context during disasters and catastrophic events?

U2. Where do roles and responsibilities for water resources management reside?
U3. Is there sufficient funding for water resources infrastructure?
U4. Is water infrastructure adequate to meet multiple social demands?
U5. To what extent do fossil fuels satisfy U.S. energy needs?
U6. How do international markets and economic agendas affect U.S. water resources management?
U7. What is the impact of environmental values on land and water resources policies and management?
U8. How do new technologies and engineering practices affect water resources management (including planning)?
U9. How vulnerable is water resources infrastructure?
U10. What is the effect of climate change on the U.S. environment and population?[1]
U11. Can available water supply of acceptable quality satisfy multiple social demands?
U12. To what extent are non-structural measures used to solve problems?
U13. To what degree are water resource construction and management privatized?

For each of the 13 uncertainties, PDT members imagined and fleshed out the extreme outcomes, i.e., the directions each factor could take. These were called polarities, and are provided in Appendix B, along with detailed descriptions of each uncertainty. Outcomes had to be simplified, and were deliberately taken to extremes. This was done so that the scenarios would be sufficiently different as to highlight risks and opportunities in the future. Table 1 below summarizes the possible outcomes of each uncertainty in the year 2035.

Table 1. Possible Outcomes of Uncertainties in the year 2035

Uncertainty	One Extreme	Another Extreme
U1. What is the socio-political context during disasters and catastrophic events?	Harmonious and unified	Fibrillating and chaotic
U2. Where do the roles and responsibilities for water resources management reside?	Local and fragmented	Federal and integrated
U3. Will there be sufficient funding for water resources infrastructure?	Sufficient funding	Insufficient funding
U4. Is water infrastructure adequate to satisfy multiple social demands?	Infrastructure fully satisfies social demands	Infrastructure is inadequate for demands
U5. To what extent will fossil fuels satisfy U.S.	Alternative sources and new technologies become	Fossil fuels remain dominant

[1] Uncertainty 10 was subsequently rephrased to "What will be the frequency and effect of disasters on the U.S. environment and population?"

Uncertainty	One Extreme	Another Extreme
energy needs?	significant	
U6. How will international markets and economic agendas affect U.S. water resources management?	Globalization, interdependence, and cooperation	Isolationism, autarchy, and protectionism
U7. What will be the impact of environmental values on land and water resources policies and management?	Environmental values are the major influence on water policies and projects	Environmental values are incidental or unimportant in key decisions regarding land/water resources
U8. How will new technologies and engineering practices affect water resources management?	Revolutionary changes in technologies and engineering practices	Incremental changes in technologies and engineering practices
U9. What is the vulnerability of water resources infrastructure?	Minimized vulnerability of water resources infrastructure	Significant vulnerability of water resources infrastructure
U10. What will be the pace and effect of climate change on the U.S. environment and population?	Gradual and minimal effect of climate change	Abrupt and dramatic effect of climate change
U11. To what extent will available water of acceptable quality satisfy multiple social demands?	Available water fully satisfies social demands	Available water is inadequate for demands
U12. To what extent are non-structural measures used to solve problems?	Significant	Minimal
U13. To what degree will water resources construction and management be privatized?	Strong private involvement	Weak private involvement

Scenario Development

The next step in the scenario-based strategic planning process was to use the trends and the extreme outcomes of the uncertainties to create scenarios. Uncertainties were deliberately taken to extremes so that the scenarios would be divergent stories of possible futures. Scenarios must also be plausible and internally consistent. They should be strategically relevant to the organization such that they will stimulate thinking about how USACE might cope and succeed if the hypothetical events in the scenarios actually occurred.

The approach was to select the two most important uncertainties and to examine the combinations created by intersecting their extreme outcomes. This would create a 2x2 matrix of four possible scenarios. Then the remaining uncertainties would be woven into a 'blueprint' for each scenario. The blueprint would then be further fleshed out into a scenario script (story) with the trends – so no information collected would be lost.

The following uncertainties were determined, by the strategic planning team, to be most important, and most likely to have a large impact on USACE. They are listed below, in order of importance:

- U4: Is water infrastructure adequate to satisfy multiple social demands?
- U3: Will there be sufficient funding for water resources infrastructure?
- U9: What is the vulnerability of water resources infrastructure?
- U1: What is the socio-political context during disasters and catastrophes?
- U10: What will be the effect of climate change on the U.S. environment and population?

The scenario matrix will not work well, i.e. will not produce four distinct scenarios, if the two major drivers are highly correlated. Therefore, the team could not just pick the top two uncertainties (U4 and U3), because these two are very interrelated. The adequacy of water infrastructure is closely correlated with the available funding. Similarly, U1 and U9 did not produce a good scenario matrix, since the vulnerability of infrastructure affects the impacts of disasters and catastrophes. Therefore, other scenario matrices were explored.

The team felt it was important to retain the adequacy of water resources infrastructure as one of the key drivers, since it was ranked highest in importance by the Senior Leaders and the strategic planning team (PDT). Based upon possible pairings done by the Institute for Water Resources and the Contractor, Decision Strategies International, it was initially recommended that the scenarios be created by pairing U4: Is water infrastructure adequate to satisfy multiple social demands in 2035? and U10: What will be the effect of climate change on the U.S. environment and population by 2035? This pairing created four plausible and internally consistent worlds, required unique USACE capabilities in each one of them, and provided the potential for monitoring external variables and signposts (e.g., climate change).

There were divergent opinions on the recommendation above, and the following compromise was reached. The major drivers would be the **status of water resources infrastructure** (uncertainty #4) and the **severity and frequency of disasters** (which took climate change into account as well as uncertainties #1 and #9). This decision generated the 2 X 2 Matrix, which is shown in Figure 1.

Figure 1. Scenario Matrix

	Infrastructure fully satisfies social demands	Infrastructure is inadequate for demands
Low frequency and severity of disasters	Plenty of Plenty	Cracking Up (later renamed Global Malaise)
High frequency and severity of disasters	New Order	Hard Times

The four scenarios can be sketched out in terms of the major drivers as follows:

Scenario A – Plenty of Plenty. In this scenario there are no great challenges in the water resources arena. Due to sufficient funding, infrastructure is well-maintained and reliable, and therefore not even noticed by most people. The amount, timing, and geographical patterns of precipitation remain within recent (last 100 years) bounds, and therefore water resources infrastructure designed and built to these specifications continues to be perfectly adequate. Climate change may be occurring, but the effects are not yet felt in the U.S. Water infrastructure brings sufficient water to where it is needed, easily responding to shifting demographics and demands.

Scenario B – Cracking Up (later renamed Global Malaise). In this scenario, the water resources field basically limps along. The infrastructure continues to age and deteriorate. There is a fix-as-fail approach; not enough money for much new construction. Water resource infrastructure by 2035 is frequently unable to meet demands, and becomes a limiting factor for community and economic growth. Luckily, this increasingly fragile system is not tested by hydrologic extremes or severe storms, so there are no catastrophes. The weather, including temperatures and water supplies, continues well within the bounds of the infrastructure's design standards.

Scenario C – New Order. In this scenario, fluctuations in temperature and precipitation regularly exceed the historical period of record well before the year 2035. There are also unprecedented storms, which, along with the droughts and floods, serve as wake-up calls for the nation. These events are perceived as harbingers of what is to come in terms of climate and hydrologic regimes, and the nation seeks engineering solutions to the problems. Erratic water supplies are solved with greater storage capacities in reservoirs.

Water resources infrastructure is redesigned and rebuilt to serve the needs of the population. The 1,000 year or 10,000 year flood (or drought, or storm) becomes the design standard, as a way of coping with the uncertain and changing water supplies and weather conditions. People are aware of, and value, water resources infrastructure, and see it as a matter of life and death, so funding is not an issue.

Scenario D – Hard Times. In this scenario, storms and water supply extremes occur, but they are viewed as anomalies by many. The effects of climate change are not fully recognized as such until it is very late (maybe too late). Long-neglected water resources infrastructure is severely stressed by the new climatic conditions, and is overwhelmed to the point of failure in multiple parts of the U.S. The government scrambles to make emergency repairs, contingency arrangements, but there is loss of life. Parts of the country become uninhabitable because of either too much or too little water. Social and political conflict abounds over water resources.

A Scenario Blueprint (Table 2) was then developed, showing how the extremes of all 13 uncertainties would be utilized to generate the four scenarios.

None of the scenarios are presented as most likely. They are all given equal consideration.

Table 2 Scenario Blueprint

Uncertainties	Plenty of Plenty	Cracking Up (Global Malaise)	New Order	Hard Times
U4: Is water infrastructure adequate to satisfy multiple social demands?	Infrastructure fully satisfies social demands	Infrastructure is inadequate for demands	Infrastructure fully satisfies social demands	Infrastructure is inadequate for demands
U10: What will be the frequency and effect of disasters on U.S. environment and population?	Low frequency and severity	Low frequency and severity	High frequency and severity	High frequency and severity
U1: What is the socio-political context during disasters and catastrophic events?	Harmonious and unified	Fibrillating and chaotic	Harmonious and unified	Fibrillating and chaotic
U2: Where do roles and responsibilities for water resource management reside?	Local and fragmented	Local and fragmented	Federal and integrated	Federal and integrated
U3: Will there be sufficient funding for water resources?	Sufficient	Insufficient	Sufficient	Insufficient
U5: To what extent will fossil fuels satisfy U.S. energy needs?	Fossil fuels remain dominant	Fossil fuels remain dominant	Alternative energy sources and new technologies become significant	Alternative energy sources and new technologies become significant
U6: How will international markets and economic agendas affect	Globalization, interdependence, cooperation	Isolationism, autarchy and protectionism	Globalization, interdependence and cooperation	Isolationism, autarchy and protectionism

Uncertainties	Plenty of Plenty	Cracking Up (Global Malaise)	New Order	Hard Times
U.S. water resources?				
U7: What will be the impact of environmental values on land and water resources?	Major influence on water policies and projects	Incidental and unimportant	Major influence on water policies and projects	Incidental and unimportant
U8: How will new technologies and engineering practices affect water resources?	Incremental changes	Incremental changes	Revolutionary changes	Incremental changes
U9: What is the vulnerability of water resources infrastructure?	Minimized vulnerability	Significant vulnerability	Minimized vulnerability	Significant vulnerability
U11: To what extent will available water of acceptable quality satisfy multiple social demands?	Fully satisfies demands	Fully satisfies demands	Inadequate for demands	Inadequate for demands
U12: To what extent are non-structural measures used to solve problems?	minimum	Minimum	significant	Minimum
U13: To what degree will water resource construction and management be privatized?	Strong private involvement	Weak private involvement	Weak private involvement	Weak private involvement

Full text of the scenarios is included in Appendix C.

Scenario Analysis – Implications for USACE Civil Works Program

The PDT, Senior Leaders, and other USACE staff next held workshops to consider the implications of each scenario for the USACE Civil Works Program. Both challenges and opportunities were identified. These are shown in the tables below.

Table 3. Implications for USACE in Plenty of Plenty Scenario

Implications for USACE – Plenty of Plenty	
Challenges	**Opportunities**
Smaller federal government; smaller USACE.	High environmental consciousness will lead to more ecosystem restoration work.
With all types of infrastructure construction and maintenance privatized, there will be a greatly reduced demand for public engineering, and it will be a challenge for USACE to retain technical competencies.	USACE's regulatory role could increase.
Not much need for emergency services and disaster recovery (at least at the federal level), so these missions and the associated skills will wither.	Increased role of setting and enforcing standards for navigation and flood control infrastructure could stimulate high-tech, remote sensing inspection and monitoring techniques.
Continued globalization will sustain lots of freight movement; some of which could spill over onto the waterways. However, expansion of inland waterways would be done mainly by the private sector; USACE's role would be limited to setting standards, and giving grants.	

Table 4. Implications for USACE in Cracking Up (Global Malaise) Scenario

Implications for USACE – Cracking Up (Global Malaise)	
Challenges	**Opportunities**
Continued shift towards a leaner, smaller USACE.	Need to hone the USACE's expertise in extending the life of geriatric infrastructure.
Need to develop better prioritization processes; identify what is really essential.	Need to develop plans for evacuation of people in the event of flood control structure and other infrastructure failures.
No funds and little support for ecosystem restoration.	Need to develop plans for rerouting freight in the case of navigation structure failures and emergency shutdowns.
Fragmented governance and lack of public support for the environment makes it difficult to implement the watershed approach to problem-solving.	

Table 5. Implications for USACE in New Order Scenario

Implications for USACE – New Order	
Challenges	**Opportunities**
Major traditional cargos of inland waterway system decline and disappear (coal and petroleum)	Increased globalization and trade mean high demand for the movement of freight throughout the U.S.; possibly new cargoes for the inland waterways.
USACE loses its regulatory program as this function is shifted to states and localities.	Increased morale and energy in USACE. Employees are happy and productive and it is easier for USACE to attract top talent.
On inland floodplains, nonstructural measures become more important.	Lots of work for the emergency management program, but USACE needs to continuously coordinate ifs efforts with other agencies. Partnering skills become more valued.
Watershed management becomes possible with a strong federal oversight role. However, water problems are exacerbated by weather extremes (both floods and droughts).	With increasing conflicts over water, the USACE's skills as integrator and balancer are needed more than ever.

Table 6. Implications for USACE in Hard Times Scenario

Implications for USACE – Hard Times	
Challenges	**Opportunities**
Isolationism leads to scaling back and eventual closing of USACE's foreign offices in Europe, the Gulf region, and elsewhere.	Increasing water conflicts lead to increased demand for dispute resolution and integrated planning skills.
Emergency Assistance and Disaster Recovery consumes most of USACE's resources.	Water supply mission becomes a major part of the USACE program.
USACE staff is smaller due to the dearth of discretionary funds in the government.	Regular USACE staff is supplemented with a network of "Auxiliary Corps workers" available on a contingency basis.

Stakeholder Consultation on Scenarios

Stakeholder input is a critical part of any strategic planning process. USACE consulted stakeholders after the scenarios were developed, and sought input on strategies which USACE might employ to deal with the diverse futures portrayed.

Methodology

USACE invited key stakeholders to participate in a discussion at the Ronald Reagan Building in Washington, D.C. on August 14, 2007. The workshop focused on the impacts of the four alternative future scenarios. Sixty-four people participated in this discussion. The scenarios were presented to the entire group. Break out sessions were held, with each team addressing a single scenario. The four teams were comprised of a mix of stakeholders and USACE personnel. They discussed strategies for success under the conditions portrayed by four alternative future worlds.

Results

The teams presented specific strategies for succeeding in each scenario. The following ten strategies were robust across all four scenarios:

1. Redefine Federal and state roles and responsibilities for water and related resources planning, development, and management.

2. Institutionalize an effective leadership structure for water resources to promote long-term planning.

3. Foster strategic alliances.

4. Think and work within a systems framework.

5. Educate and communicate about risk.

6. Promote an environmental consciousness and conscientiousness in the general public, among planners and decision makers, and in youth (the future workforce).

7. Adopt innovative and flexible investment mechanisms and strategies for public water resources development.

8. Maintain sufficient investments for America to be a leader in science, technology, research and development, and technology transfer.

9. Use a life-cycle approach to infrastructure planning, management, and maintenance.

10. Maintain technical expertise and disaster preparedness.

This stakeholder input was used in the development of the key success factors, which was the next step in the process. Many of these ideas also appear in the cross cutting

strategies, which were the most important output of the scenario based strategic planning process, and form the essence of the FY 2010 to 2014 USACE Civil Works Strategic Plan.

Key Success Factors

A Key Success Factor is defined as a discriminating capability, resource, or activity that organizations must possess to create competitive advantage. They cannot be bought from the outside, but must be developed from within. Each KSF entails a complex system of interrelated components that reach deep and wide across the organization.

The PDT began the key success factor development process by thinking about the scenarios and the implications of these possible futures for USACE (summarized in previous section). For each scenario, the team asked the following questions:

- What actions could USACE take today to prepare for the future as depicted by this scenario?
- How can USACE reduce its strategic risk exposure and capture some of the emerging opportunities?
- How could USACE succeed in this scenario?
- What is the winning business model?

Business program managers were interviewed and asked to answer the above questions from the perspective of their particular business program. The USACE Civil Works Program is implemented through the following 'business programs': navigation; hydropower; flood risk management; regulatory; ecosystem restoration or environmental stewardship; water supply; emergency management and disaster recovery; Formerly Utilized Sites Remedial Action Program (FUSRAP); and natural resources and recreation. Stakeholders were also consulted on strategies which would be effective in each of the scenarios (see previous section), and this input influenced and shaped the development of the key success factors as well. All of the responses were consolidated, grouped into categories, and examined for their effectiveness and applicability across both scenarios and business programs. The results of this analysis are presented below in Figures 2 and 3 and Table 7. Complete details of the key success factor analysis by business program and scenario are contained in Appendix D.

The potential key success factors were clustered into the following groups:

- 1 = Develop and Manage Strategic Alliances
- 2 = Understand and Communicate Risk
- 3 = Operate Cost Competitively, Efficiently
- 4 = Attract, Train, Develop, Retain, Reward Workforce
- 5 = Develop, Store, and Transfer Mission Area Knowledge
- 6 = Ability to Expand and Contract Operations Rapidly
- 7 = Lead in Application and Transfer of Selected Technologies
- 8 = Customize and Innovate Financing
- 9 = Catalyze Solutions to Water Resource Problems and Conflicts
- 10 = Prioritization of Work
- 11 = Preparedness
- 12 = Miscellaneous

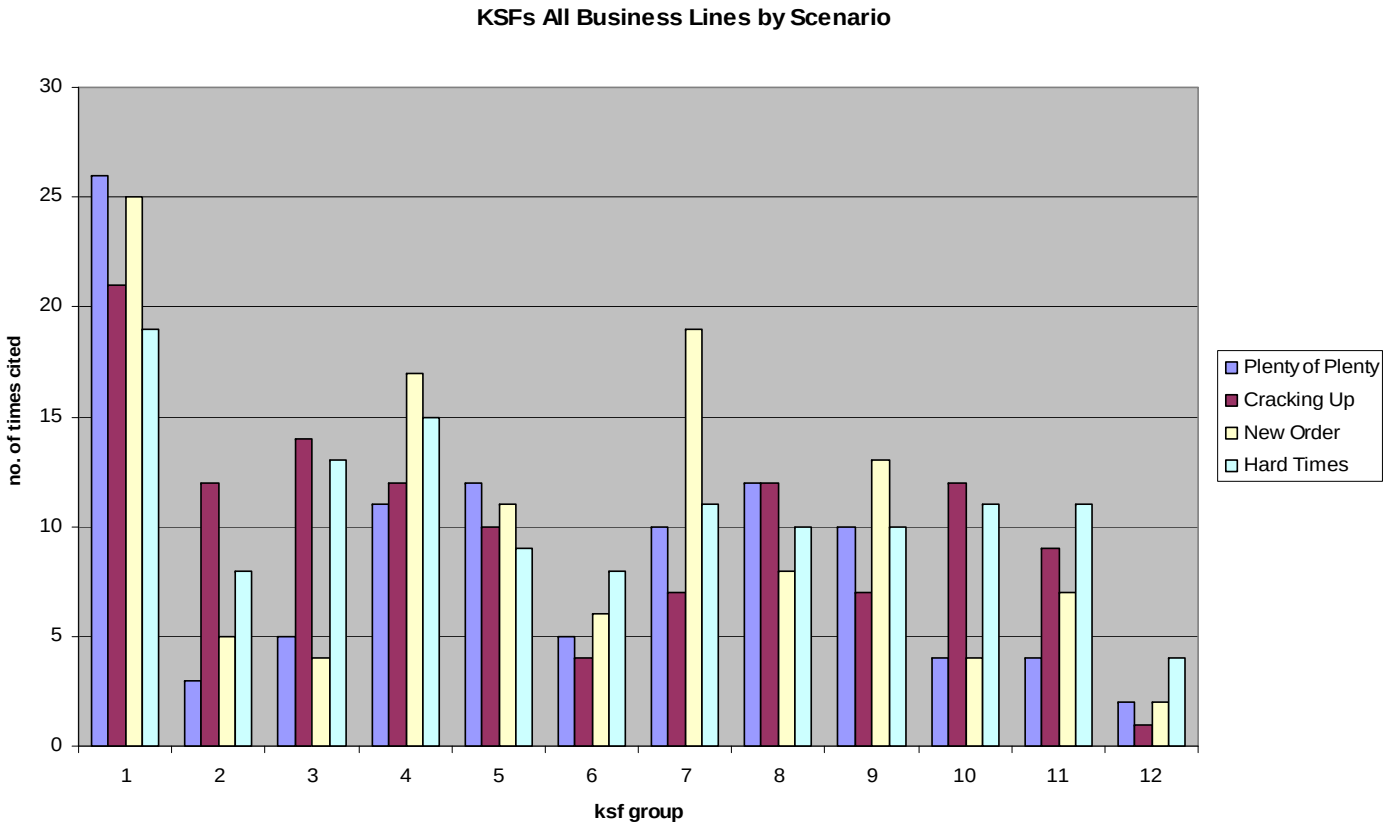

Figure 2. Robustness of Key Success Factor Groups Across Scenarios.

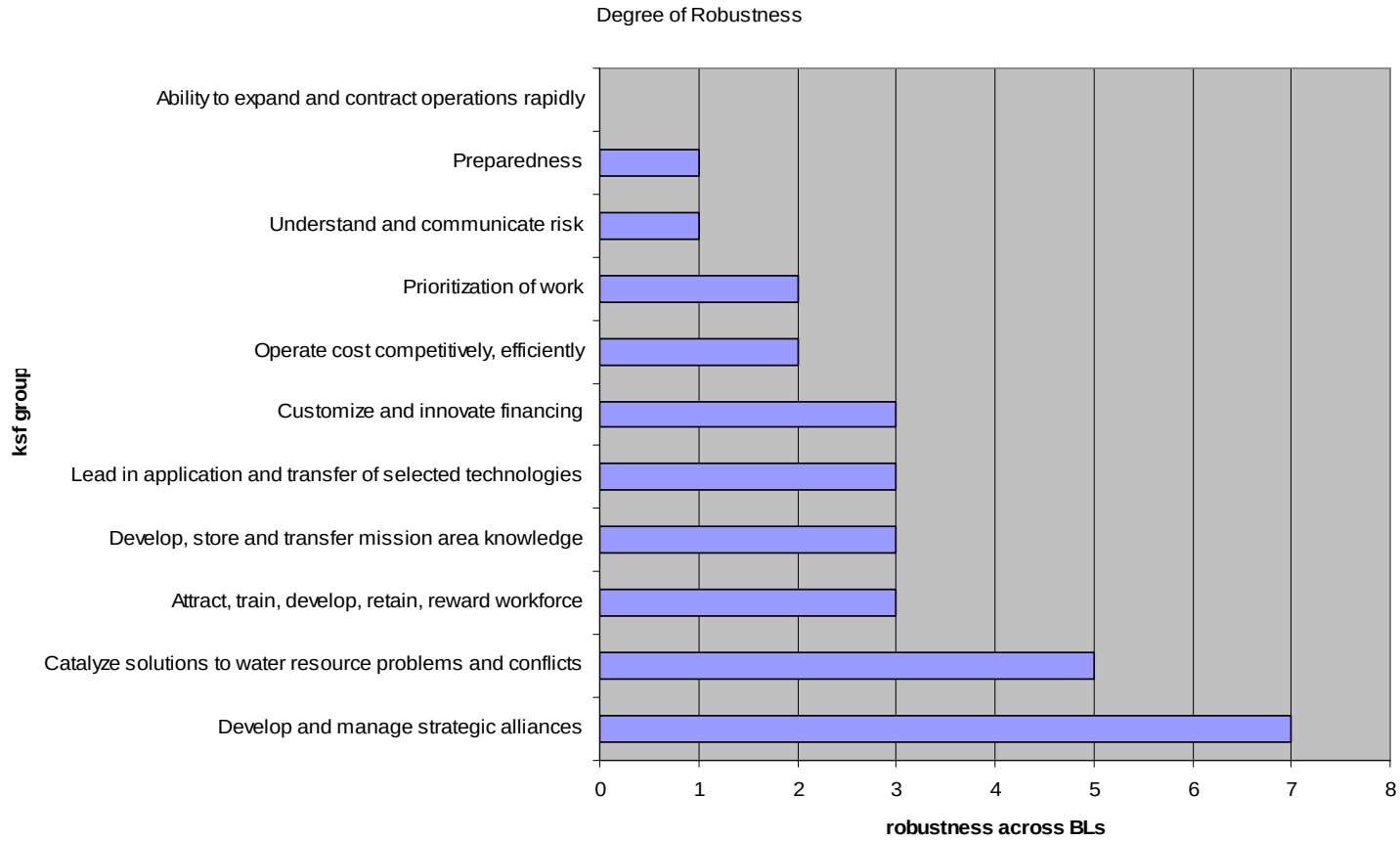

Figure 3. Robustness of Key Success Factor Groups Across Business Programs

Table 7. Top Three (Most Important) Key Success Factor Groups by Business Line

Key Success Factor Group	Navigation	Hydropower	Flood Risk Mgt	Regulatory	Ecosystem Restoration	Stewardship	Water Supply	Emergency Mgt	Fusrap	Recreation	Total
Develop and Manage Strategic Alliances		X	X		X	X		X	X	X	7
Understand and Communicate Risk			X								1
Operate Cost Competitively, Efficiently	X			X							2
Attract, Train, Develop, Retain, Reward Workforce								X	X	X	3
Develop, Store and Transfer Mission Area Knowledge				X	X				X		3
Ability to Expand and Contract Operations Rapidly											0
Lead in Application and Transfer of Technologies	X	X	X								3
Customize and Innovate Financing		X				X	X				3
Catalyze Solutions to Water Resource Problems and Conflicts				X	X	X	X			X	5
Prioritization of Work	X						X				2
Preparedness								X			1

This analysis was followed by workshops and discussions, wherein many of the most robust (i.e. applicable for most scenarios and for most business lines) themes and groups found their way to the list of Key Success Factors below. Other concepts emerged during the discussions, such as adaptive management. Both the systems approach (KSF 1) and integrated water resources management (KSF5) were drawn from the group labeled 'catalyze solutions to water resource problems and conflicts'. 'Develop and manage strategic alliances' was expanded to KSF 3 – Build and Sustain Partnerships.

Key Success Factors

1. Effectively Implement a Comprehensive Systems Approach – Examine all interdependent aspects of problems and solutions to effectively balance, integrate, and manage a broad portfolio of mission responsibilities.
2. Risk-Informed Decision Making - Do Risk Analysis and Risk Communication – Make and communicate risk-informed project, program, and policy decisions. Employ risk-based concepts in planning, design and construction operations, and major maintenance.
3. Build and Sustain Partnerships -- Enable strategic partnerships and alliances, in both public and private arenas.
4. Promote Water Resources Policy Development -- Provide leadership in developing future water resources policy.
5. Practice Integrated Water Resources Management – Focus on sustainability. Anticipate needs and deliver comprehensive, sustainable water resources solutions in contentious and complex environments.
6. Emphasize Reliable Public Service Professionalism – Attract, develop, reward, and retain a competent, capable workforce. Manage and enhance technical expertise and professionalism.
7. Build and Share Corporate Technical Knowledge – Codify and effectively communicate institutional knowledge, standards, and technical excellence.
8. Use State-of-the-Art Technology – Invest in research and lead in the application and transfer of technologies to solve water resources problems.
9. Pursue Innovative Financing – Obtain and innovatively leverage monetary resources.
10. Practice Adaptive Management – Plan, design, build, and operate water resources infrastructure to meet contemporary needs in ways that continually incorporate insights and lessons from reflection on and evaluation of experience and impacts.
11. Emphasize Teamwork and Collaboration – Mobilize the capability of the total USACE team.
12. Demonstrate Operational Responsiveness and Flexibility – Expand and contract operations rapidly and with agility.

These key success factors were used to develop a set of cross cutting strategies that formed the essence of the CW Strategic Plan.

Strategic Segmentation

The idea behind Strategic Segmentation is that an organization should understand its 'market' and how that market may be changing, because different segments of that market may require different strategies or approaches. With respect to USACE Civil Works projects and programs, two key variables are the level of customer sophistication and the geographic scope of the activity.

Methodology

The steps in segmentation are:

1. Scope out/define the market – map out the business, which in the case of USACE is water resources, infrastructure.
2. Identify strategic segmentation criteria – two key dimensions
3. Develop a segment matrix – interconnect the two dimensions/cells/segments
4. Select strategic segments
5. Conduct a deeper strategic analysis of segments

There are several ways to segment a market, including:

- By product or service
- By customer profile
- By delivery channel
- By geographic region
- By growth or profitability

Results

The team considered several criteria for segmentation, and after much debate, settled on: 1) Geographic Scope of the Activity, which ranges from small municipalities and local projects, to regional entities such as river basin commissions, to national or international activities such as Great Lakes Basin studies, the Columbia River Treaty, or the new UNESCO International Center for Integrated Water Resources Management (ICIWaRM) which is housed at the Institute for Water Resources; and 2) Sophistication of the customer (their capabilities in water resources management), which determines the type and level of service that they need from USACE. A segmentation map, or matrix, was developed using these two criteria, and it is shown in Figure 4 below.

Figure 4. Segmentation Map of USACE Activities

Segmentation Map of USACE Activities			
	Geographic Scope of Activity		
	Local, small scale Project	*Regional*	*National, International Activities*
Low Customer Sophistication	Segment A – Do It for Me, turnkey support for individual government entities		Segment D – Save Me, USACE support for natural and manmade disasters
Medium Customer Sophistication		Segment C – Do It With Me, highly independent government entities that are dependent on each other	
High Customer Sophistication	Segment B – Cater To Me (I'm in Charge),		Segment E – Complement Me, USACE support to international governments

Each segment was discussed in depth, and the detailed descriptions are included in Appendix E.

Conclusion

The market for USACE products and services seems to be shifting in the direction of higher customer sophistication and towards more integrated, national and international activities. USACE's strategic direction is moving towards integrated water resources management. This will require more emphasis on regional, national, and global activities. New work will be focused on the Do It With Me, Save Me, and Complement Me segments. This represents a shift toward working on a larger scale, on more complex projects with more sophisticated customers, and working with those customers who have emerging capabilities.

Core Competencies

Core competencies are the roots of an organization, discriminating capabilities that distinguish it from other competitors in the field. Core competencies are defined as:

- Complex set of skills, knowledge, and resources that span the organization
- Skills that yield a sustainable competitive advantage in the marketplace
- Skills that permeate the organization's culture, evolve over time, and are based on specific "know how"

An example of a core competency is supply chain management in the WalMart Company.

Core competencies are few in number, hard to imitate and transfer. They should not be outsourced. They are diffused across groups of employees. They evolve over time, and cannot be replicated easily. The litmus test for a core competency is that it provides a large competitive advantage and is hard to imitate.

Methodology

The team brainstormed on the question, "What differentiates USACE from other government engineering organizations?" A workshop was held, breakout groups generated ideas for core competencies. Possible core competencies were evaluated based on the following criteria:

- Competitive advantage
- Hard to replicate, imitate, or transfer
- Provides value to customers
- Applies across all business programs
- Exists broadly across employees in all parts of the organization
- Sustainable and durable over time

Results

The following were identified as Core Competencies for USACE's Civil Works Program.

1. **Integrator** – Ability to leverage resources, knowledge and people to provide comprehensive solutions to problems
2. **National/Global Perspective** – Ability to think globally/ in the national interest and to act locally; a world-wide presence

3. **Balancer** – Ability to balance multiple / competing interests and demands
4. **Systems Thinking** – Ability to think in terms of an entire whole (system) and to manage complexity
5. **Diverse Technical/Scientific Workforce** – Ability to recruit/develop/maintain a diverse technical and scientific work workforce. USACE is the Nation's expert in water resources and civil engineering.

6. **Marshal Resources** – Ability & willingness to marshal resources to address new challenges quickly. This stems from the command and control military culture and heritage.
7. **Integrated Delivery** – Ability to execute and deliver complex engineering and scientific projects. This includes cradle to grave execution, large scale projects.

Strategic Direction, Vision, Mission, and Goals

In this phase of the process, the emphasis shifted from 'what might happen to us?' to 'what do we want to make happen?'

USACE's mission is to *Contribute to the national welfare and serve the public by providing the Nation and the Army with quality and responsive:*

- *Development and management of the Nation's water resources;*
- *Protection and management of the natural environment;*
- *Restoration of aquatic ecosystems;*
- *Flood risk and emergency management; and*
- *Engineering and technical services*

in an environmentally sustainable, economic, and technically sound manner with a focus on public safety and collaborative partnerships.

Stemming from this mission, USACE Civil Works has developed four strategic goals. These goals were updated as a result of the scenario-based process, although not drastically changed. The goals are:

- Safe, Resilient Communities and Infrastructure.
- Sustainable Water Resources, Marine Transportation Systems, and Healthy Aquatic Ecosystems
- Effective, Reliable, and Adaptive Life-Cycle Project Performance
- Sustain a Competent Team

A workshop was held on strategic direction, and the conclusion was the USACE Civil Works Program needs to move towards a vision of sustainable water resources development by employing an overarching strategy of integrated water resources management. Table 8 below illustrates this shift in terms of several key variables.

Integrated water resources management (IWRM) views water resource challenges and opportunities holistically. IWRM promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems. Such integration is essential for the future success of the Civil Works program given the Nation's multi-layered governance system that crosses watershed boundaries and the interdependent relationship between the natural and built environment.

Table 8. Strategic Direction, Moving From…….To

Focus	From	To
Success Equals:	Projects	Comprehensive Plans
Decision Criteria	NED benefits	Balance NED, EQ, RED, OSE benefits
Work	Stay in functional lane	Seek horizontal integration
Knowledge	Knowledge is power	Shared data sets
Style	Follow SOPs as recipes	Think creatively, consider systems, risks
Money	Limited to Federal Dollars	Leverage resources of all society
Infrastructure	Build to demand, increasing size and capacity	Manage demand, take advantage of all cost-effective options before increasing infrastructure capacity
Integration	Integration by accident	Integration by design
Collaboration equals	Public relations	Engagement, enlist other agencies and the public in the search for effective, multi-benefit, sustainable solutions

Cross Cutting Strategies

The major outcome of the scenario based strategic planning process was a set of cross cutting strategies that are effective across all scenarios, USACE business programs, and market segments. These strategies formed the centerpiece of the FY2010 to FY 2014 USACE Civil Works Program Strategic Plan. These **Cross Cutting Strategies** are described below.

1. Systems Approach – Use of systems analysis tools to model the interconnected nature of hydrologic systems and the economic and ecologic systems they support, and also identify and evaluate management alternatives.

The systems approach to water resources shifts the focus of making decisions from individual and sometimes isolated projects to an interdependent system, and from local or immediate solutions to regional and long term solutions that consider the entire life-cycle of projects. This new way of thinking and working recognizes that water resources problems and opportunities exist in systems of interdependent parts (inputs, processes, outputs, ultimate outcomes, and feedback loops from each).

A systems approach reflects the reality that water exists in physical and social/cultural systems such that any single action triggers one or more responses and reactions in other parts of the system. The USACE will describe systems as natural or ecological systems and as sets of interlinked processes and programs. From these system descriptions, the resources and stakeholders that are integral to these systems can be identified, and solutions with an appreciation for the interconnections can be developed.

A systems approach reveals the wisdom of looking at a river basin, watershed, or coastal zone as a whole. For example, taking a systems approach means looking at the interactions and possibly competing needs among all water uses and water users, including navigation, ecosystems, flood risk management, recreation, water supply, and hydropower.

Systems approaches and models can help planners and decision-makers deal with the complexities of a system, however it is defined. One such systems approach is Regional Sediment Management, a way to view the movement of sediment holistically. Such an approach illuminates sediment as a resource rather than as dredged material requiring disposal. This allows a focus on beneficial uses of dredged material such as wetland creation and beach nourishment.

2. Collaboration and Partnering –Build and sustain collaboration and partnerships at all levels to leverage funding, talent, and data from multiple agencies and organizations.

Partnerships allow each organization to contribute resources and thus to assemble a greater pool of assets to solve problems. The willingness and skills to partner with other agencies and organizations is crucial to accomplishing USACE's missions. Partnerships

need to be built and sustained to leverage funding, talent, and data from multiple agencies and organizations.

Partnerships across Federal agencies create efficiencies when scarce resources are combined toward common aims. An enhanced effort is needed to partner with the increasingly sophisticated state and interstate organizations. Partnering with Tribes, local entities, and private not-for-profit entities will continue. Partnering with profit-making organizations is a logical next step that deserves additional investigation.

One partnership ripe for collaboration is with state water resources planners. States are facing critical water shortages and/or excessive flooding from such external factors as population migration and global warming. Another issue they face is sedimentation in reservoirs, which is reducing storage capacity for water supply. The USACE's strength in multiple water functions, project management, conflict resolution, and use of decision-support technologies such as Shared Vision Planning, position USACE to facilitate comprehensive, coordinated, and integrated water resource planning. Not only can USACE experts and state water resource planners form a nexus of interests to solve current problems, they can also join forces to look ahead and to seek opportunities for greater cooperation in the larger watersheds where USACE-managed reservoirs exist.

3. Risk-Informed Decision Making and Communication – Develop and employ risk and reliability-based approaches that incorporate consequence analysis, especially risk to population; identify, evaluate, and forestall possible failure mechanisms; and quantify and communicate residual risk.

USACE must better integrate risk-informed decision making across its Civil Works program to include planning, design, construction, operations, and maintenance. This process includes risk assessment, risk management, and risk communication. USACE must ask the difficult questions of which water resources projects will fail to perform as expected or designed, the likelihood of failures, and the consequence of such failures. There is an increasing recognition of the limits in disaster prediction and the protection provided by structural means against extreme events. A strategy to fully integrate risk analysis within USACE planning and operations which involves those impacted by a project is a significant challenge, but an important goal.

4. Innovative Financing – Beyond traditional government appropriations, seek innovative arrangements such as public-private partnerships, adjustable cost-sharing requirements, revised funding prioritizations, increased use of user-based fees, and other funding mechanisms to develop and sustain the Nation's water resources infrastructure.

The USACE must explore innovative means of financing and not be limited to traditional government appropriations in the accomplishment of its missions. If discretionary Federal funding is insufficient to support selected water resource programs and services, new financing mechanisms will be required. Innovative financing encompasses a number of arrangements such as adjusting cost-sharing requirements; de-authorizing projects; changing funding prioritization; re-organizing or modifying existing funding mechanisms and accounts; greater use of user-based fees; and public-private partnerships.

Various forms of public-private partnerships can be effective when there are shared goals (i.e., ecosystem restoration) between USACE and non-governmental organizations. In the hydropower area, funds provided by preference customers in the Northwest and transferred directly to USACE through the Bonneville Power Administration already demonstrate how outside maintenance funding can maintain hydropower assets. The other three U.S. Power Management Administrations also use direct reimbursement funding though to a lesser extent. Other water resources infrastructure construction and operations and maintenance could be accomplished through a mix of private and public funding. In summary, the application of a life-cycle approach to operate and maintain projects over their design life can be an advantageous arrangement for both the government and private sector.

5. Adaptive Management – Using the insights gained from monitoring data, measure the responses to interventions within systems and adjust planning, construction, and operations in response to changing conditions.

Adaptive management, a principle commonly used in ecosystem restoration, is a means to learn from monitoring that measures responses to system interventions. Such insights can be used to develop future actions or change approaches. Adaptive management fosters continual learning, which benefits an organization by guiding flexibility in project operations and maintenance.

Adaptation has always been an important skill, and in a rapidly changing world is even more essential. Adaptive management provides feedback concerning how parts of a system work and affect other parts of the system. Climate change and the threat of greater extremes in precipitation and timing will require adaptation in the operation of existing infrastructure as well as revised standards in the planning and design of new water infrastructure. Disasters, both natural and manmade, may require an ability to expand (and later contract) operations rapidly. Agility and responsiveness is a necessary quality for future success by any of the Federal, state, or local water resource agencies.

6. State-of-the-Art Technology – Embrace new and emerging technology for its fullest advantage. Invest in research that improves the resiliency of structures, assists in updating design criteria, and improves approaches toward planning and design.

Investment in research and development must continue to provide both the technology that addresses contemporary problems and future requirements. The research and development laboratories, organized under the USACE Engineering Research and Development Center (ERDC), will facilitate this innovation. In partnership with the Institute for Water Resources (IWR) and Centers of Expertise, ERDC will employ technology transfer to infuse new technologies into practice.

Advances in communication, information accessibility, remote sensing, and nanotechnology are particularly relevant to USACE missions. The Coastal and River Information System (CRIS) is one example of modern communication technology used

to improve the efficiency and safety of the inland and intracoastal waterways. This system enables electronic capture of waterborne commerce data, management of waterborne traffic, and real-time communication with vessel operators concerning water traffic and hazards.

Additionally, advances in remote sensing and geospatial information systems will facilitate monitoring of critical infrastructure such as dams and levees on both a routine basis and under periods of critical attention such as hurricanes. Investments in technology are investments in future adaptability and agility that enhance the health, safety, and welfare of the public.

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Next Steps

Strategic planning is an ongoing process. Even though the Strategic Plan may be written, strategic thinking and strategic actions should continue. A few important next steps are therefore suggested in this section.

Use the Cross Cutting Strategies

The challenge at this point is to use the cross-cutting strategies to move USACE's Civil Works Program in the desired strategic direction, towards the desired vision.

The USACE Civil Works vision is "A great engineering force of highly dedicated people working with our partners through disciplined thought and action to deliver innovative and sustainable solutions to the Nation's water resources planning, engineering, construction, and operations challenges."

Table 8 below proposes some 'actionable first steps' for each cross-cutting strategy which USACE might take to begin such a transformation.

Table 9. How Cross-Cutting Strategies Might Transform USACE

Cross-Cutting Strategy	Core Actions	End States (Visions of Success) - Outcomes
Systems Approach	Train staff to consider broad implications of decisions, to balance development and environment, competing water uses, life and safety.	USACE successfully delivers sustainable products/projects in contentious and complex environments
Collaboration and Partnering	Focus on improved collaboration at the state level. Reward successful partnering efforts	USACE is viewed as a desirable partner; other organizations at all levels seek out collaborative activities with USACE. Most programs and projects are done with partners, rather than alone.
Risk-Informed Decision Making and Communication	Change culture/process from single point criteria approach to a use of a life-cycle risk informed decision framework. Develop methods to communicate risk to the public.	Risk-based decision making is used in engineering, economics, operation, ecosystem, construction, budgeting, and emergency management. People affected by USACE projects and activities understand the residual risks.

Cross-Cutting Strategy	Core Actions	End States (Visions of Success) - Outcomes
Innovative Financing	Think broader than Congressional appropriations; seek other sources of financing.	Sufficient financing is available for USACE to carry out its missions.
Adaptive Management	Seek expanded authorities to incorporate adaptive management into projects' life cycles. Utilize and learn from monitoring data that measures the responses to interventions in systems.	Monitoring results inform and enable USACE to continually learn, improve, and adjust to changing conditions
State-of-the-Art Technology	Engage the Research and Development program to apply new technology to USACE civil works missions and activities	Blue ribbon panel report?

Develop Contingent Strategies and Triggers for Implementing Them

Contingent strategies are those that are only effective, or acceptable under certain conditions. Contingent strategies should be designed with trigger events and trends. These must be coupled with monitoring of the weak signals (discussed below), and current events. Also, some of the contingent strategies may not only be good in certain conditions, they may be necessary. So plans need to be in place to activate these strategies at the right place and right time. The basic requirements are identifying leading indicators that would signal the need for a contingent strategy, and then a monitoring system to track those indicators. The results of this monitoring need to be communicated to senior leaders at regular intervals.

The USACE Civil Works strategic planning team did not develop contingent strategies, but an example of one is the development of a workforce which can quickly expand (in times of disaster) and contract (when the disaster is over). Such an expandable disaster management capability might be created by supplementing regular staff with a network of 'Auxiliary Corps' workers. They would be located across the Nation and would be trained and ready to respond, paid a small stipend to be on call for disasters. When deployed they would be paid full salaries by the USACE and given leave from other jobs, like a civilian reserve force.

Monitor the Weak Signals

The world is constantly changing, and the key uncertainties identified in this process are moving towards one extreme or the other. Monitoring of current conditions, sometimes

called ‘weak signals’ can provide intelligence on which scenario the world is moving towards, which contingent strategies should be deployed, and on new factors or forces that were not previously known or considered.

It is vital to keep a watchful eye on the world, especially as global events transpire and shape the USACE operational context. Employees positioned across the USACE could be ‘keeping an eye’ on the external environment, thinking about how events might impact USACE missions. Information could be collected and shared via web-based technology. Analysts could then provide relevant findings to senior leadership.

A comprehensive process could be set up to identify all potentially significant emerging trends and to determine a subset of the most important issues to USACE missions. A team could identify early warnings that specific scenarios may be unfolding by articulating a handful of key variables that influence the mission areas. Variables would be monitored on a regular basis. People in the groups could be rotated to bring in diverse perspectives, fringe ideas. Senior leaders could be briefed regularly on these topics.

Reexamine the Scenarios

Companies and agencies that use scenario planning as part of their strategic planning process typically revisit and rebuild scenario sets every few years, as particular strategic threats and opportunities become evident. For USACE, the five-year strategic plan renewal cycle would be an appropriate time to reexamine the scenarios and look for new insights to shape the Civil Works Program’s strategy.

Critique and Lessons Learned

There are no right, wrong, or even fixed answers in scenario based strategic planning. The whole process is subjective and much more art than science. Fresh insights are the goal, and the strength of the process lies in obtaining a critical mass of creative and knowledgeable people and obtaining sufficient inputs and analyses at each stage.

A weakness of the USACE scenario based process was that only a very small group of people were involved and contributed substantively to the effort. This was partly by design (only the Senior Leaders and the PDT were invited to participate), but was exacerbated by poor attendance at many of the workshops and limited engagement of those who did attend.

Another problem was that the majority of those who did participate in the workshops (typically about 4 hours every two months) had very little time for any follow up work between the meetings, or to properly digest and provide comments on interim products. Consequently, the vast majority of the work was completed by a handful of people.

Future scenario based strategic planning exercises should cast a wider net, engage a broader cross section of USACE staff in addition to experts outside the USACE and other stakeholders.

Having regional MSC representatives on the PDT was likely not enough to cause the scenario process to seem real to the field. Although most MSC representatives made an effort to attend most of the workshops, there was no evidence that they communicated the scenario process to their constituencies or solicited field input.

Attendance was often poor among the senior leadership group. Executives sometimes sent substitutes who were not senior executives. However, it should be mentioned that this exercise was occurring in 2006 and 2007, at a time when all USACE leaders and staff experienced very heavy workloads in the aftermath of Hurricane Katrina, and the Chief of Engineers was also simultaneously involving the senior leaders in developing a new Campaign Plan.

It is important to have interim products and drafts read closely and constructively criticized by participants, outside experts and stakeholders. This did not happen in the USACE process.

In conclusion, if this process is undertaken again it should be much more collaborative. Scenario based strategic planning needs the time and intellectual energy of many more people. There are benefits in the process as well as the product. The ideas generated and insights gained by participants influence their thinking and their work. If more had been involved, especially outside the USACE, the product, the USACE Civil Works Strategic Plan 2010 to 2014, might have been richer and the ancillary benefits would definitely have been greater and more widespread.

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Appendix A – Identification, Description, and Evaluation of External Factors (Driving Forces)

Methodology for Identification of External Factors or Driving Forces

The following methodology was used to identify a set of driving forces impacting water resources management and infrastructure in the United States between the present time and 2035. An interdisciplinary team was formed along the lines of the STEEPS areas (Social, Technological, Economic, Environmental, Political, and Security), and each person was assigned to research potential fundamental drivers in his/her subject area.

Information was gathered from a literature search, discussions with staff at the Institute for Water Resources and other professional networks, and review of the work of "thought leaders" who write/talk about future trends and issues. The following resources were used, along with others.

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- Udall Center and Department of Hydrology, University of Arizona, http://udallcenter.arizona.edu/
- Rand Corporation, Santa Monica, CA, http://www.rand.org/

This research produced a list of 124 Factors, and each one is briefly described below. The statements were formulated directionally, e.g. "an increase in…" or "declining…"

F1 U.S. population is increasingly urbanized, concentrated in large megalopolises.
Urbanization and suburbanization change the hydrology of watersheds, affecting sediment loads, runoff, water quality, and increasing demands for municipal water supply, flood control, dredging, etc.

F2 The concept of "office" has changed to accommodate the needs and desires of workers to a greater degree, allowing for virtual work from home or elsewhere outside the office and across time zones.
Most people work at home. With continued development of databases and PC connectivity, it is just as easy to be at home, and there is lower overhead. There will be greater emphasis on technology in the workplace, and greater need for the worker to have technology in the home. There will be less commuting traffic, smaller office space. Social benefits of personal interaction at the office may be compromised. Over the longer term, population could become more dispersed, rather than concentrated in urban centers.

F3 There is a diffusion of centralized authority as competency and advocacy increase among local and grass roots entities.
The trend in distrust of central authority, started in the 1960's, continues. There are multiple veto points. There is confusion about who's in charge and decision-making gridlock, which will affect budgeting (ability to derive consensus about allocation of resources in a timely way).

F4 There is a polarization of views taking place, reflecting increased fundamentalist thinking.
Loss of moral grounding from lax religious upbringing or incentives for personal wealth building is revealed in increased incidents and reporting of ethical lapses in businesses, religious institutions, and public affairs. There is a blurring (changing notion) of traditional ethics. It is more difficult to appeal to commonly accepted notions of "right" and "wrong." There is a breakdown in influence of authority, e.g., teachers over students and loss of respect for those endowed with public trust.

F5 There will be increased use of instant wireless communications (e.g., blackberries, teleconferencing) to facilitate telework and long-distance teaming, collaboration, and learning.
There will be less need for travel to in-person meetings and increased ability to draw on geographically scattered expertise to solve problems and work on projects. Another outcome is information overload, where there is so much extraneous information that it is difficult to identify and concentrate on what is truly relevant.

F6 Electronic measuring devices make it easier to measure vessel tonnage (displacements) and movements of vessels.

This would make collection of waterway user fees easier and more automatic; also collection of waterborne commerce data could be streamlined.

F7 As technological change accelerates, so will the rate of technological obsolescence.
For example, according to EPA, Americans have about 500 million old, unused cell phones, and they go through approximately 130 million more each year, the equivalent of 65,000 tons of waste. Cell phones contain toxic metals such as arsenic, beryllium cadmium, copper and nickel. While some companies offer take-back programs, most cell phones are not disposed of properly. There will be increasing quantities of e-waste and expense incurred from having to stay current with technology.
Source: Trends in America, the Council of State Governments, June 2005.

F8 The Sub-Saharan African economy remains devastated and poverty persists in this part of the world.
The economy is not robust enough to develop infrastructure or raise the people out of poverty. There is no discretionary money to build infrastructure.

F9 Cargo flows into and out of ports increase dramatically.
Land transportation systems become overwhelmed. Security concerns might limit imports to a few ports, further exacerbating congestion. Expansion or not of the Panama Canal could shift cargo from one coast to another. Cost and availability of freight transport by rail and road could affect the amounts of cargo going to one port vs. another.

F10 The U.S. economy declines due to triggers and external shocks such as rapid escalation of oil prices, a large-scale environmental disaster, collapse of international financial markets, and sudden withdrawal of foreign capital from the U.S.
The Federal government and/or private industry could be called upon to rebuild/upgrade water resources infrastructure. Much of the current inland waterways navigation system was constructed in the depression of the 1930's.

F11 The percentage of the U.S. Gross National Product (GNP) spent on defense increases because of the Global War on Terror.
There may be fewer resource allocations to discretionary Federal and State programs.

F12 There is a decline of government bureaucracies, a shift from Central Planning to Market Systems in the world.
Some governments have privatized extensively by selling public enterprises, whereas others have relied heavily on non-governmental partners for service. In both cases, they have struggled to change the driving incentives of public policy. Underlying all tactics is a basic strategy: replace traditional bureaucratic command-and-control mechanisms with market strategies and then rely on these strategies to change behavior of program managers.
Source: Donald F. Kettl, The Global Public Management Revolution. Brookings Institution, 2000.

F13 Loss of wetlands continues, but at a slower rate than in the recent past.
The goal of no net loss of wetlands remains elusive. Average annual loss of wetlands has decreased over the past 40 years, but is still occurring at a current estimated rate of 58,500 acres per year.
Source: U.S. EPA , National Water Quality Inventory: 2000 Report.

F14 Brownfields cleanup receives more emphasis.
Brownfields cleanup results in more small-scale cleanups at a lower level. USACE assistance could be offered to communities, Native Americans, and other Federal agencies.

F15 Human activities continue to degrade and alter the ecosystem.
This results in severe stress on the life support system, possibly exceeding the carrying capacity of the planet.

F16 There is more downsizing, privatization, and outsourcing of Federal roles.
As downsizing continues and agencies with similar missions are reduced with initiatives such as privatization and outsourcing, there comes a certain point in which Federal or state authorities may be asked to do part or all of a mission with the objective of increasing efficiencies for the cost of doing business. This could result in the consolidation or elimination of USACE water resources missions within the Federal government.

F17 Inter-state political squabbles increase as water resource issues are stressed through competition for water.
Because of its unique inter-state role, the Federal government will increasingly be the arbiter in these contentious situations. Thus, the Federal role in watershed planning could become more critical than before to seek agreement across all key stakeholders about roles and responsibilities for large-scale planning.
Sources: A discussion of interstate issues in the Southeast U.S. is contained at: http://eerc.ra.utk.edu/divisions/wrrc/sws/paper.htm
A discussion by Interior Secretary Gayle Norton on Western U.S. water use conflicts is contained at: http://www.citizenreviewonline.org/may_2003/feds.htm
The DOI homepage on Water 2025: Preventing Crises and Conflict in the West is contained at http://www.doi.gov/water2025/

F18 Government becomes more business-like and business becomes more conscious about public policy issues.
The ease of working for government under FERS (employees can come and go) brings ideas from the private sector into the federal bureaucracy, as do those who attend civilian graduate school. Since the 1960s and the McNamara era, administrations have experimented with business models to improve efficiencies and cost effectiveness. As the private industry workforce blends with the government workforce, business and financial management ideas blossom within the bureaucracy. One possible outcome is the loss of a public ethic grounded in preserving water resources for the public good as

market-driven models begin to proliferate and influence decision making in the government.

F19 Some regional power or non-state actors will use nuclear power/weapons.
Attacks with a few nuclear weapons will not necessarily lead to massive nuclear response, but there could be panic and health risks to the population affected by an attack.

F20 Politicians will continue to use their influence to bring homeland security funds to their home districts.
Greatest security needs do not necessarily coincide with the home territories of the most powerful politicians despite weaknesses in the degrading national infrastructure.

F21 World population will continue to increase, although rates of change will vary geographically, with higher growth in the developing countries.
The number of people drives basic demand for water supply, water-based recreation, hydropower, even the products transported by navigation.

F22 Water problems are increased in complexity (scope and scale), as characterized by multiple stakeholders, conflicting objectives, high levels of uncertainty as to measures and their effectiveness. The complexity of water problems increases at a greater rate than confidence in our ability to solve these complex problems.
We think we can do a lot more than we actually can, leading to overconfidence. We think we know more than we actually know, i.e. every time water flows are changed in an environment, the impact is largely uncertain. The current planning process becomes inadequate. Federal agencies need to cultivate a culture of uncertainty, a planning process that better incorporates risk and uncertainty, needs to monitor the results of earlier efforts and incorporate them into adaptive styles of management.

F23 There will be increasingly decentralized decision-making systems, with power originating from many sources because of the proliferation of fast, flexible, decentralized information technology tools.
There will be less top-down managerial direction, a flatter organizational structure, more teaming and customization to meet individual needs and characteristics. Self-managing process teams emerge. Interdependence replaces independence. Constant communications. A virtual organization. Fewer middle managers. Perhaps more empowered employees or employees who demand individualized management and incentives.

F24 Attitudes toward public water management shift from a proponency for control to a proponency for sustainability, i.e., from structural to nonstructural solutions to water resource problems.
There is added pressure on the Executive Branch through legislation to complement its structural projects with non-structural measures such as zoning restrictions and upstream flow management measures. These measures can reduce emergency response costs and promote risk-compatible floodplain uses.

Sources: A discussion of minimizing engineering impacts is contained in: http://www.epa.gov/water/speeches/062303tm.html ; a series of quotes from Gilbert White, including some pertinent to this issue is contained in: http://www.colorado.edu/hazards/gfw/quotes.html

F25 Ever faster and better information and communication technologies pervade every aspect of our society.
This factor affects the government's ability to detect, analyze, mitigate, remediate, and disseminate solutions to water resources problems. Things such as Global Positioning Systems (GPS), which can communicate the exact positions of ships and barges, electronic charts which can communicate current conditions in rivers and channels, sensors that automatically measure stream flows, depths, etc, all provide information that can impact the management of water resources and infrastructure. The Internet makes it possible to disseminate hydrologic and other scientific information both within the government and to external stakeholders instantly and inexpensively. This new information technology also allows for more public participation in the policy-making process. The downside of the new information technology is that it can be used for evil as well as good: civilization is increasingly vulnerable to cyber-terrorism, power outages, information pollution (misinformation, pornography, junk email, media violence), and to virus attacks.

F26 U.S. leadership in science and technology wanes, as evidenced by the fact that many American goods retain a stigma of poor quality and even worse servicing.
This leads to a worsening trade imbalance, with imports exceeding exports. Decline of U.S. automobile industry. Rise of Asian high technology industry. Nations that produce high-quality goods will take over American markets (e.g., automobiles, electronics).

F27 Technology (e.g., new survey equipment; remote sensing, GPS) has greatly enhanced our ability to image and characterize the physical world, making it easier to acquire field data.
Fewer survey crews are needed. High-tech equipment increases.

F28 Although new technologies such as the Internet, satellites, nanotechnology, biometrics, radio frequency identification, and DNA analysis have many benefits for society, their acceptance and implementation is hindered by concerns over the erosion of personal privacy.
There is a tradeoff between privacy and security, and the balance point could shift either way. Data mining is being used to reduce waste, fraud, and abuse, but it can also lead to personal profiling. Private companies use data mining to market specific services and products to fit individual needs, but it also gives them access to vast amounts of personal information about individuals and families, such as purchasing patterns, personal finances, and medical conditions.
Source: Trends in America, the Council of State Governments, June 2005.

F29 There will be economic expansion and increasing productivity in Latin American countries.

This might affect immigration, trade patterns.

F30 Trade will continue to increase rapidly with the Pacific Rim countries, particularly China.
Volume of imports could overwhelm U.S. ports and transportation system.

F31 The disparity between the "haves" (e.g., northern hemisphere countries) and the "have-nots" (e.g., southern hemisphere countries) will fuel global unrest.
Southern hemisphere countries are generally in huge debt to northern hemisphere countries, and this increases international tensions. Forgiveness of African nations' debt was on the agenda of the G8 summit this year. Poor countries may need engineering expertise and technical support, but may not be able to pay for it. Increasing debt and subsequent bankruptcy can lead to tighter credit and slowed expansion.

F32 Native American corporations become a viable economic unit due to casino revenue. Many Native American corporations invest their revenue into community action programs and infrastructure development.
Native American corporations may take on increased responsibilities for social service programs and water infrastructure, or pay a proportion of the costs involved.

F33 The pattern and type of agricultural activity shifts, affecting the need for irrigation, the need for transport of crops to markets, and demand for water resources and related infrastructure.

F34 Biodiversity declines as more species become extinct. The single biggest threat to species survival is loss of habitat.
A Nature Conservancy study, "Precious Heritage: The Status of Biodiversity in the United States." found that as many as one-third of the nation's species are at risk and at least 500 species are extinct or missing.
There will be strong opposition to any federal government project that destroys or alters critical habitat, and support for environmental restoration projects and other management activities (i.e. pool drawdowns, stream flow support, environmental windows for dredging) that protect threatened and endangered species and increase diversity.

F35 The amount of money invested by both government and private sector in environmental protection and improvement programs increases.
Environmental compliance costs may be considered a cost of doing business. Environmental mitigation is expected. Large environmental restoration projects cannot be challenged for political reasons, and the smaller projects will be off the radar screen and not worth challenging. Medium-sized ones may be eliminated. The presumption of "do no environmental harm" will continue.

F36 Regional conflicts and war in the Middle East, South Asia, Baltic States, China, Near East Asia, Southern Hemisphere of the Americas are a threat to the U.S.
Economic resources are diverted to wage and sustain the war and to rebuild infrastructure in Iraq. Federal deficit increases and funds for domestic infrastructure are constrained.

Substantial discretionary spending and resources are diverted to support the warfighting effort and to assist with post-conflict stabilization reconstruction.

F37 There is a re-sizing of the Federal workforce and overhaul of the Civil Service laws with respect to GS ratings, performance appraisals, RIF procedures underway.
Performance appraisals are eliminated. There is an increase in use of bonuses and other incentives for successful completion of tasks in order to retain employees. RIF revamped to downplay the seniority factor in employee retention. Contracting methods for personal services are made easier. It will be easier for employees to come in and out of government or to return to support government work on a part-time basis after retirement.

F38 The courts are increasingly used to resolve water conflicts.
Federal resources may be needed to handle the lawsuits, possible abandonment of some projects.

F39 Public confidence in the U.S. military increases because the military is seen as a can-do organization.
The U.S. military may assume expanded roles in emergency management during natural disasters and pandemics. The military roles in humanitarian relief, peacekeeping, civil affairs, and reconstruction may grow.

F40 Global calamities (natural and manmade disasters such as nuclear accidents like Chernobyl, oil spills, and geological eruptions) incur prolonged and extended impacts which lead to political and social turmoil and global instability.
Global calamities can significantly change the distribution of economic resources and distribution of wealth and power within the U.S.

F41 The balance of Federal, State, and local roles related to infrastructure security shifts as infrastructure security demands rise.
Who pays? Who is responsible? Who implements?

F42 People migrate from the water-rich areas of the north and east in the U.S. to the water-short areas of the south and west.
Where people are located in relation to water resources is a factor affecting the infrastructure required to provide water supply. The geographic location of population, especially in coastal areas and floodplains, also affects their vulnerability to water events such as floods, droughts, and storms.

F43 The Baby Boom and the Aging of America; Baby Boomers have reached retirement age, and people are living longer and having fewer children, resulting in a lot more older people in the U.S. and less younger people to support them.
According to the U.S. Census Bureau, the number of people older than 65 will more than double between 2000 and 2050, and the population over 85 will quadruple. Fueling this population transformation are the 76 million baby boomers born between 1946 and 1964. This unusually large demographic group has changed America's institutions as they have grown older, starting with schools and then moving into the work force. The boomer's

upcoming exodus from the work force will gain momentum rapidly as the first wave of boomers turns 65 in 2011. Most of the leadership in the Federal agencies is comprised of the post-WWII Baby Boom generation, now in the 45 to 60 age bracket. One implication is that this group is now moving into retirement and taking a lot of expertise and institutional knowledge with it. Alternatively, economic pressures could result in baby boomers working longer, after retirement age, because they can't afford to retire. Still another side of this is the opportunity to replace these people with others who have a different set of skills, expertise, and attitudes, thus restructuring the capabilities of the work force and the contract support workforce that the government may employ in the future.
Sources: U.S. Census Bureau, and Trends in America, Charting the Course Ahead, the Council of State Governments, June 2005.

F44 The workplace creates jobs that demand higher skills than the labor pool can meet.
There is a downward trend in technical professional capacity and competency, and in the numbers of engineering and planning-bound college graduates. This is exacerbated by technological ignorance; people cannot comprehend rapidly changing technology.
Some Federal agencies may need to do remedial training and on-the-job training of entry-level employees. May need to bring back retirees on a part-time or contract basis to mentor younger employees.

F45 Religious beliefs have more impact on public policymaking.
Values conflicts over religious preference will begin to shape public policies, e.g., nature of curriculum in public schools – conflicts between those espousing evolution and those espousing Intelligent Design. What constitutes "good science" will be up for grabs, affecting criteria for decision making in public agencies.

F46 Computers as we know them today will become invisible, literally absorbed into their surroundings and embedded in walls, carpets, toasters, neckties, and even our own bodies.
As computing dissolves into the environment it becomes as pervasive as the electricity flowing through society. Some scientists suggested the earth will be wrapped in a digital skin, transmitting signals over the internet almost as a living creature relays impulses through its nervous system. Millions of sensors probe and monitor highways, cities, factories, forests, oceans and the atmosphere. There will be an unprecedented level of connectivity. Because managing connectivity on a scale like that will be too difficult for humans to do on their own, network management will be partially delegated to software programs called agents that learn about their users and act autonomously on their behalf. The way humans interact with computers changes profoundly. Instead of typing commands onto a keyboard, humans use speech and physical gestures to communicate with computers much as they do with other people. Computer networks are adaptive, intelligent, and self-organizing.
Source: Charles W. Schmidt, freelance science writer living in Portland, Maine, writing for the Millenium Project.

F47 Advancing frontiers in biotechnology, especially genetic engineering, such as bioremediation methods for in-situ, cost-effective environmental cleanup, materials science, biological creation of high-performance polymers, advances in gene therapy, advances in cloning offer both bright promise and potential threat, as the very building blocks of life are manipulated to search for solutions to a broad spectrum of problems.

F48 There will be more demands to maintain technical capability, causing a greater percentage of workers' time to be spent on training in the future.
Lifelong learning will be necessary to keep pace with changing technologies. On-site or TDY training will become obsolete. More training either in the office or at home from PC-based , interactive equipment.

F49 Changes in internal combustion engines and how we use fuels, the fuels we use, hybrid cars, fuel cells, nuclear technologies will lead to changes from highways to skyways and smart highways, where people can sleep on the way to work and cars drive themselves for personal transportation.
Just as the automobile revolutionized and reshaped our society, new modes of transportation are likely to have wide-ranging impacts.

F50 Economic losses associated with natural disasters will grow as the incidence and scope of disasters increases.
There will be a huge need for government disaster relief and increased coordination across levels of government. Partnerships with NGOs may proliferate to cover costs and response/recovery services.

F51 The Federal budget for water resources is reduced given warfighting requirements, increases in entitlement programs, and deficit spending.
Despite changes in Congress, Administration, political parties in control, and a major attack on the nation, the water resources budget has remained nearly constant over the past two decades in real terms. Within the Federal budget, entitlement spending has increased in relation to discretionary spending. The war on terrorism puts even more pressure on the Federal budget. The Federal water resources program (discretionary spending) will continue to compete with other priorities and needs for funding (mandatory spending). Budget could increase in response to disasters and need for cleanup and reconstruction, otherwise it will likely remain flat or decline.

F52 U.S. budget deficit continues to increase.
There is a mushrooming deficit, exacerbated by lengthy war in Iraq, recent disaster in New Orleans and the Gulf Coast.

F53 The amount of freight needing to be moved in the U.S. will increase dramatically.

There is worsening congestion on the highway system, railroads, creating an impetus to move more freight by water routes. Containers on barges and short sea shipping increase. Source: A discussion of modal trends is contained in: http://www.bts.gov/publications/us_international_trade_and_freight_transportation_trends/2003/pdf/entire.pdf

F54 The climate changes globally as witnessed by a rise in land and ocean temperatures, increases in sea level, melting of permafrost, more extreme precipitation events, etc.

The amount, timing, and geographic distribution of precipitation determine the basic supply of water, timing and magnitude of runoff. Temperature regime affects water temperatures, evapotranspiration, formation of ice. It may also affect the frequency and intensity of storms. A change in global climate would have major impacts on aquatic ecosystems and both the quality and quantity of water available for human use. Existing water resources infrastructure has been designed and built for the recent (last 100 years or so) climate. If that changes, it has big implications for the effectiveness and performance of such infrastructure. Land use and population shifts would result, with changing water demands. Reduced river flows would hinder navigation and force increased reliance on irrigation. Crop patterns would change. May stimulate efforts to reduce greenhouse gases. Could mean more storms, rising sea levels, extremes of floods and droughts in certain areas.

F55 Fossil fuels do not keep pace with demand, and use of alternative energy sources increase dramatically.

Energy shortages and possible supply disruptions could trigger increased demand for hydropower, wind power, solar power, increased use of hybrid electric cars. This could result in more demand for permits for siting of wind generators and changes to USACE hydropower facilities to supply more hydroelectric power would change flow regimes. Possibly less grain traffic on the Mississippi if corn is converted to ethanol rather than exported. Less air pollution, less reliance on foreign oil.

F56 There is increased development and use of conservation and energy efficiency standards in design of buildings.

This could affect water use, design of public offices and facilities (military and civil) that the federal government builds.

F57 Interdependence among the major nations increases due to globalization of finance, trade, economics, telecommunications, politics, thus diminishing the sovereign power of individual nations.

Economic shifts in the rest of the world have more impact on the U.S. Age of U.S. dominance in the world economy may be over.

F58 There is continuation of a trend toward erosion of the non-Federal share in Federal water projects since the passage of the Water Resources Development Act of 1986, as evidenced by an ever-increasing list of exemptions and exceptions from cost-sharing in subsequent legislation.

The Federal government will pick up more of the costs associated with public works projects.

F59 Agricultural interests lose their influence in Congress as compared to the influence of urban interests.
Both interests have demands for water: agriculture for irrigation, urban for municipal water supply.

F60 There is increasing tension between Federalism and State rights given an expanded Federal role in standard setting, e.g., in education, the "no child left behind" standards.
The desire to ensure quality breeds faith in standards and national standard-setting. This could lead to confusion about the boundaries of the federal role; unfunded Federal mandates.

F61 The rise of political Islam continues, due to youth bulges in Arab countries, unemployment, and the effects of orthodox religious education (fundamentalism).
Although it could conceivably have a positive outcome, the rise of Islamic fundamentalism so far has mostly been expressed violently, with a sharp increase in terrorism. The future could hold more threats to U.S. people and infrastructure.

F62 Decentralization of many programs to lower levels of government becomes a major focal point in many governments.
This means shifting power within the system – from Federalism to State rights. Service delivery responsibilities will shift to states and local authorities over autonomy and incentive to respond to citizens' needs.
Source: Donald F. Kettl, The Global Public Management Revolution, Brookings Institution, 2000.

F63 People keep moving to coastal areas, particularly in the South and Southeast where there is high incidence of hurricanes, increasing human and property vulnerability to wind and flood damages, even loss of life.
Increasing population in these areas could create further demands for coastal protection and requirements for emergency assistance. Resources for these activities are likely to be at the expense of other program activities, such as water resources as contingency operations account for a greater proportion of the discretionary budget.
Sources: See special report produced by NOAA.
http://www.oceanservice.noaa.gov/programs/mb/pdfs/coastal_pop_trends_complete.pdf
A discussion of coastal population trends by region is contained in:
http://www.oceanservice.noaa.gov/programs/mb/pdfs/e_regional_trends.pdf
A discussion of U.S. hurricane landfalls is contained in:
http://www.mcwar.org/articles/landfall/landfall.html

F64 The U.S. Population continues to migrate to the South and West Regions (arid areas).

Increased population in these arid and semi-arid environments will alter the demand for water supply and increase conflicts over water use. There could be potentially big needs for water projects; conflicts over water use, especially municipal water supply vs. agriculture. Alternatively, persistent and unresolved shortages of water could lead to migration back to water-rich areas, i.e. the "rust belt".
Sources: A discussion of water supply conflicts is contained in:
http://www.gcrio.org/CONSEQUENCES/spring95/Water.html
An interesting perspective on western water issues, specifically dealing with privatization of water supplies is contained at: http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2004/07/11/INGBJ7I02E1.DTL

F65 There is increased real-time distribution, availability, and access to information through the mass media.
Instant multi-media coverage abounds. The messages that people receive from the media affect public opinion and complicate policy making; increased opportunity for information distortion to influence public opinion and public policy making.

F66 The middle class in the U.S. shrinks, as more slip into poverty.
Growing, or maybe continuing, gap between rich and poor in the U.S., and the social issues that arise from this. The disparity between the "haves" and "have nots" may cause the middle class to disappear.

F67 There is a shift from Newtonian physics (equilibrium, cause and effect predictability, the more you study a system the more you can understand it) to biology (nondeterministic, dynamic systems, hard to predict where it is going) as a dominant paradigm in the U.S.
This raises questions about people's faith in models, scientists' ability to predict, and the uncertainty of their predictions. This deterministic to nondeterministic shift has shaken the public's reliance on scientific expertise. Within the scientific community, the mantra of sound science now is about acknowledging uncertainty. However, the public thinks sound science should offer certainty.

F68 Expanded use of complex interactive computer models makes reproducing and evaluating real-world situations easier.
There are potential payoffs in areas such as design and construction, diagnostics, training, and engineering management. Improved global models will more accurately address environmental issues such as global warming and atmospheric pollutant transport.

F69 As technology advances and societies become more refined and their activities more elaborate, their members become more deeply reliant on external systems and services.
Such advances in technology may increase vulnerability. Computer viruses, identity theft, etc. Potentially devastating consequences if computer systems fail; need for fail-safe backups.

F70 The U.S. shifts to a service-based economy focused on ideas and knowledge, one that involves different skill sets than those required by the previous manufacturing-based system.
The old economy was characterized by large firms that did not always respond quickly to change. The new economy is characterized by smaller, innovative, flexible firms that can take advantage of rapidly emerging and changing niche markets. There will be a need for continuous training and learning in the work force.
Source: Trends in America, Council of State Governments, June 2005.

F71 Levels of Traffic on the Marine Transportation System remain static.
Level of traffic affects current operations and maintenance activities, as well as the ability to justify expansion and modernization of the inland waterway system and deepwater ports.

F72 There is increased dependence on the private sector to support services traditionally provided by the government.
Private firms could be operating the locks and dams of the inland waterway system. The government could lose technical expertise if a significant amount of engineering work is outsourced. The public could face the rise of a "hollow government." Another outcome: private financing of highway and water supply infrastructure. Greater use of tolls and special taxes.

F73 The level of consumer, business, and government debt increases.
This could result in social strife; collapse of economy and business; huge savings/ retirement losses; reduced agency budgets; downsizing; reduced spending for public works infrastructure; reduced global competitiveness; increased poverty levels as people foreclose.

F74 Container ships increase in size and require deeper channels.
Larger containerships are already here: OOCL's "Shenzhen" is 8,000 TEUs, the size of a 15-story building. There are 6 in service, 6 more on order. These ships require 47.7 feet of draft (loaded). This could result in more pressure to deepen ports.
Source: A discussion of port infrastructure issues associated with mega-ships is contained in: http://www.joc.com/Top_Container_lines_2004.pdf

F75 The incidence and severity of storms and natural disasters increases.
If storms and other disasters become more severe than before and more frequent, they can overwhelm the infrastructure and result in human and economic losses (i.e., Katrina, other hurricanes). The Federal government may need to reevaluate the adequacy of flood and coastal protection projects, and strengthen, raise levees, expand beach nourishment, etc. The government also plays a role in emergency management following natural disasters and destructive storms, and this may increase. Another possible outcome: the public becomes critical of scientists' ability to forecast and planners' and engineers' ability to provide facilities safe from climatological events. More money goes into disaster relief and less into safe structures. There is increased impetus for flood plain management and hurricane-safe housing.

F76 New exotic species will be introduced into America's lakes and rivers, and those already present will expand their range.
This leads to increased ecological and economic disruption, and more research and remedial actions to control the species.

F77 There is no agreement about what "environmental restoration" means.
Diverse views of what environmental restoration means proliferate. Does restoration mean to pre-Columbian conditions? This affects the design and extent of government-sponsored environmental restoration projects and program.

F78 Technologies of the Information Age, combined with decentralization and the rise of market economies, place more freedom of choice and power in the hands of smaller groups and individuals than ever before.
The price to pay for this shift--pushing decision-making down and out to the lowest feasible levels, may be greater instability and the eruption of violence among factions. Decentralization of decisions leads to growing power of ethnic and nationalistic factions within established nations and geopolitical boundaries. Civil wars, and regional conflicts resulting from attempts to consolidate ethnic groups into new ethnic-based nations, may have spillover effects on neighboring countries and contribute to global instability (Iraq, Iran). On the other hand, evolving international geopolitical climate with a discernable trend toward freer, market-oriented economies and democratic governance may reduce risk of conflict between the superpowers. Flavor of democratization may be variable, not follow the federalist republic model of the U.S., as constitution-building in Iraq is showing.

F79 There is more innovative financing of public infrastructure, e.g., mixed combinations of financing, such as a) greater share of state funding and lesser share of Federal appropriations; b) greater share to private entities and state/local authorities and a lesser share of funding to the Federal government.
This could result in more collection of Federal user fees because of more private sector involvement in the development and operation and maintenance of the nation's infrastructure.

F80 As the relative portion of population increases in coastal areas, the political influence of coastal residents and coastal states will increase also.
One possible outcome is that Federal authorities will receive greater support for more shore protection projects.

F81 The boundaries between war, civil unrest, terrorism, and crime are increasingly blurred.
There are suicide bombers, dirty bombs, unimaginable surprises like flying airplanes into buildings. Acts of terrorism, insurrection, and conflict could destroy critical water infrastructure, precipitating urgent needs for alternative supplies, emergency measures, rebuilding of structures. This could lead to increased cost of security at public works

projects and in the design, construction, and operation of public works projects. Risk and reliability studies will be needed, and will be tied to capital investment decisions.

F82 Conflicts over water help countries and regions resolve other conflicts.
Cooperation among Israelis, Jordanians, and Palestinians, as well as Chinese, Indians, and those in Southeast Asia over water involves processes of negotiation and decision making that could serve as a model of collaboration. Demand for the government to extend its collaborative planning skills, alternative dispute resolution, shared vision planning, etc. internationally, leveraged by other governments and NGOs.
Source: "World Trends & Forecasts, Government," The Futurist, Mar-Apr 2004, p. 9. on website http://www.wfs.org/forecasts.htm

F83 Public trust in government institutions declines and many citizens believe that government programs are unresponsive and duplicative.
Instead of designing programs from the point of view of service providers (especially government officials) and managing them through existing bureaucratic structures, public policy reformers have tried to put citizens (service recipients) first. This means training government program managers to focus on service to the recipient (end user). Government reformers will use market mechanisms and market forces to offer citizens choice and encourage the government bureaucracy to become customer oriented.
Source: Donald F. Kettl, The Global Public Management Revolution, 2000.

F84 Attitudes toward human and environmental health positively affect the funding for safe water supplies, municipal wastewater treatment systems, cleanup of contaminated waste sites, ecosystem restoration, protection of endangered species and their habitat.
Environmental issues may gain greater political currency and constituency. Pressures for efficient, effective, and timely cleanup of hazardous and toxic waste sites may continue. Environmental attitudes will increasingly affect political decision-making and new international forums and institutional arrangements focused on the global environment, will play a larger role in international policy arenas. Cleanup of environmental problems, reversing detrimental effects of past projects through environmental restoration, may constitute a large portion of the Federal budget. There could be more emphasis on the watershed approach, sustainable development, and partnerships or joint ventures with others.

F85 Much of the immigration from Latin America to U.S. settles in the South and West (arid regions).
This immigration adds to the internal migration pressures, further increasing demand for already strained water supplies. Greater need for new infrastructure, conflict resolution, and basic municipal services and schooling to accommodate population increases.

F86 Voter preferences for environmental protection/restoration of natural resources and services and the development of environmental and human resources contribute to determining the pace of public investment in natural resources management and the environment.

NGOs directly lobby government as well as influence it indirectly through public preferences. Future tax dollar competition for development, environment, and social-medical security may increase with population increase and demographic change, including an aging population.

F87 The two major political parties in the U.S. are clearly divided along ideological lines, and there is a lack of willingness to compromise on principles. Each "camp" believes in its fundamental world-view. There will be continued polarization of political ideology (Red State vs. Blue State mentality).
Compromise and consensus are difficult to achieve, and this can lead to political gridlock, burnout and frustration among elected officials and voters. Polarized politics may increase political participation by mobilizing voters and advocates on all sides of an issue. However, continued polarization runs the risk of alienating the general public, causing them to turn to independent candidates or third parties, or away from politics altogether.
Source: Trends in America, the Council of State Governments, June 2005.

F88 Robotics are rapidly advancing.
There are more automated locks, computerized river information systems, new dredging technologies, new construction and repair methods.

F89 Advances in artificial intelligence will change the way in which computers process information, with machine intelligence that can augment and mimic human intelligence through perception, learning, induction, deduction, and discovery, affecting real-time control and self-diagnostic and self-repairing systems.
There is commercial application of fuzzy logic to control devices promises to make operations and maintenance of mechanical systems (locks?) more efficient.
Source: A discussion of incorporating smart technology into transportation projects is contained in:
http://www.artba.org/transportation_builder/pdf/TB_sept_2003_cover_story.pdf

F90 Human skills such as caring, judgment, intuition, ethics, inspiration, friendliness, and imagination that cannot be automated will become more important and valued.
As these human skills become more valued, job duties emphasize such things as situation-management and problem-anticipation skills, compassionate support of others.
Source: Richard W. Samson, "How to Succeed in the Hyper-Human Economy," The Futurist, Sept-Oct 2004, p. 40. World Future Society website accessed 9/9/2005
http://www.wfs.org/forecasts.htm

F91 America is a cashless society where nearly all money moves electronically.
USACE funds also move electronically, less need for paper checks, faster movement of money, greater application in times of crisis or emergencies.

F92 Economic productivity will continue to increase.
This affects assumptions for planning and budgeting.

F93 As Third World countries become developed and the populations become educated, and as capital flows into them to take advantage of low labor rates, the demand of these populations for goods and services will accelerate.
Third World economies will grow at double-digit rates, creating increased demand for goods services, energy, and water. The U.S. government and private industry may assist these countries with water resources development.

F94 Economic and political trends will shift power, influence, and programs away from the Federal government toward state, local, regional, and private sectors.
This means transferring more governmental service delivery responsibilities to local authorities to make government more responsive to the people (citizen-centric). There will be increasingly higher-cost sharing percentages for project sponsors; potential decrease in local willingness to sponsor projects; possibly divestiture of Federal lands, programs and funds to the states. New innovative public/private partnerships and other complex working arrangements evolve (joint ventures, partnerships, offloading). Thus, decentralized government gives frontline managers greater responsibility to respond to citizens' needs.

F95 Water markets based on water rights and water transfers will be used to meet increasing high-value demands such as domestic water supply.
The development of water markets must be factored into projections of future demands for new water resource investments. What stance will the government (Federal, State, local) take regarding water markets in its planning and regulatory decisions? USACE might facilitate better use of its existing projects by altering its pricing, reallocation of storage and other policies affecting the ability to use its storage capacity in the most productive way. There may be a potential to reduce demands for future investments in water resources.
Sources:
http://www.usbr.gov/recman/wtr/wtr-p02.htm
http://www.cato.org/pubs/pas/pa104.html
http://www.ifpri.org/2020/focus/focus09/focus09_11.htm

F96 Water becomes a scarce resource in many parts of the U.S. (and the world), increasing the potential for conflicts over water use for human consumption, agriculture, industry, power generation, recreation, navigation, flood control, and habitat for fish and wildlife.
Implications for the government might be that multi-use projects are a fact of life. Projects may need to be simultaneously managed to provide water for human consumption, agriculture, industry, power generation, recreation, navigation, flood control, and habitat for fish and wildlife. Government may need to reinvigorate its expertise in dispute resolution.

F97 Seemingly benign human activities, such as generation of nuclear power, are found to cause human health and ecological damage.

USACE is tasked to help implement engineered solutions/controls/remediation to the activity causing the problem.

F98 As environmental knowledge grows, even more questions and uncertainties regarding environmental systems are revealed.
There will be continued risk and uncertainty associated with environmental restoration projects. Impacts of measures will need to be carefully monitored for successes and failures, and continually adjusted.

F99 The accountability movement leads to increased public scrutiny of public policy and political decision making.
Instant communications lead to instant public reaction and all decisions are made in a "fishbowl" environment. Governments are committed to deliver what they promise to the public through the governance mechanism known as accountability. The ability to manage public issues and public programs effectively and work cooperatively with differing agencies and governments, becomes an increasingly important performance criterion for public agencies (from growing complexity). Governments are replacing the top-down, rule-based accountability systems with bottom-up, results-driven system. Thus, the focus is on outputs and outcomes upon which federal program budgets get based instead of processes and structures. As a result, demand for prioritization of Federal projects is becoming a necessity.
Source: Donald Kettle, The Global Public Management Revolution, 2000.

F100 There is more integration and "jointness" (Purple Suits) among the armed forces.
This would lead to less military service rivalry and parochialism, greater interoperability, significant cost savings gained efficiencies in warfighting and institutional operations.

F101 There is increasing pressure to use grants and incentives vs. direct government services.
Governments provide housing vouchers rather than public housing; funding rather than in-kind services. Pressure for grants without accountability may shift public view of government as an entitlement program. Grant programs may lower standards de facto as political pressure mounts to give grants.

F102 Nuclear, chemical, and biological weapons are easier to obtain, and reach the hands of non-state actors and hostile third world countries.
There are increased threats to the nation's infrastructure, more attention to security in water resources and related infrastructure. There could be a dirty bomb in a U.S. city. Contamination of water supplies. Disease epidemics. Destruction of infrastructure. Federal authorities engage in cleanup and restoration to restore the public's confidence.

F103 There is continued emphasis on homeland security; more public attention to security issues.

The cost of USACE projects could increase substantially if security from terrorists is factored into project design, construction and operation; thus adding to the burden of justifying and funding the civil works program.
Source: One example of the impact of risk from terrorism for ports is contained in: http://www.floatinc.com/BtH_Implementationwhite_paper.pdf

F104 Localities with sufficient water resources/resources will seek to control more or all aspects of water infrastructure and consumption. Localities without sufficient water sources/resources will look to state and Federal governments and the courts to acquire water sources/resources.
The active control of water will decrease agricultural and industrial development and reduce/restrict population growth in the locality. Within some localities, a capped amount of water rights will convey with the sale of property based on the historic level of water use/consumption for that specific property. Those who can afford this property and can live with the restriction(s) will have freedom of movement/relocation and a known availability of water. Those who can't afford the property or can't live with the restrictions will be economically excluded from the locality. An exception may be a limited number of individuals who are given a work permit "day pass," but may not take jugs of water with them at night.

F105 Scandals, the results of USACE studies, and complaints about project processes damage the reputation and public trust of USACE.
The credibility and integrity of USACE leaders and employees is questioned as well as the results of its studies and project processes. Requirements for Independent Peer Review stem from this loss of trust. Whether or not the Federal government is trusted and believed by the public to be honest has an impact on its ability to obtain resources and to deliver Federally funded programs. Negative image of a Federal agency makes it difficult to recruit/retain the best and brightest; does not inspire great productivity; produces morale erosion and distrust of services and products produced.
Reference: National Wildlife Federation and Taxpayers for Common Sense, Crossroads: Congress, the Corps of Engineers and the Future of America's Water Resources, Washington, D.C. 2004.

F106 Cultural and Ethnic Diversity in the Population of the U.S. and the U.S. Public Sector Workforce increases.
The U.S. Census Bureau estimates that immigrants comprised about 12 % of the total U.S. population in 2004 with 34.2 million people, an all-time high number of people. Most of these immigrants come from Latin America (53%) and Asia (25%). This could lead to a diversity in values, and value conflicts given values differences. Federal agencies will need to incorporate proactive "valuing differences" and "management of diversity" programs, which some Federal agencies are already doing. The work force will be more diverse in every way. These factors affect not only the routine work of the agency, but age and family responsibilities can affect the ability of employees to mobilize in emergency situations.

F107 Models based on consensus building are increasingly used for planning as contrasted with the rational optimization model reflected in Federal planning guidelines and underlying the Federal budgeting process.
This model seems to underlie much of restoration planning despite nominal application of the rational model. (See Indian River Lagoon—South Project Implementation Report.) Disconnects between nominal guidance and actual practice create confusion within certain federal agencies and with the general public and result in losses of credibility for the agency within the executive Branch (related to trust and reputation).
Sources:
http://www.beyondintractability.org/m/consensus_building.jsp
http://www.maine.gov/consensus/ppcm_consensus_examples_dot.htm
http://www.fhwa.dot.gov/hep/tribaltrans/montsalish.htm

F108 There is a growing global interdependency of markets and labor forces.
Western culture, fashions, music, films, etc. is quickly spread across the world. Some countries embrace this; others resist it. Opposing forces are created. Other aspects of globalization are financial rule sets for international banking, the Internet, global labor competition.

F109 Despite the fact that the technology for genetically engineered or transgenic crops is improving, support for using it does not materialize.
A transgenic crop plant contains a gene or genes which have been artificially inserted instead of being acquired through pollination. The inserted gene sequence (known as the transgene) may come from another unrelated plant, or from a completely different species: transgenic Bt corn, for example, which produces its own insecticide, contains a gene from a bacterium. Transgenic technology enables plant breeders to bring together in one plant useful genes from a wide range of living sources, not just from within the crop species or from closely related plants. Depending on where and for what purpose the plant is grown, desirable genes may provide features such as higher yield or improved quality, pest or disease resistance, or tolerance to heat, cold and drought. There is increased suspicion of the public in engineering crops, which could affect the ability to provide food and nourishment to underdeveloped nations.
Source: http://www.colostate.edu/programs/lifesciences/TransgenicCrops/what.html

F110 With increasing public access to government information, government workers will operate in a fish bowl, i.e., demands for transparency will increase.
The Federal government will need to develop new storage and access policies for such data/info. Honesty and integrity will be essential.

F111 As computer equipment, surgical tools, and communications pipelines shrink ever smaller with the advent of nanotechnology, the next step in engineering is to merge biological and mechanical molecules and compounds into really, really small machines.
Nanotechnology encompasses activities at the level of atoms and molecules that have applications in the real world. A nanometer is a billionth of a meter, about 1/80,000 of the diameter of a human hair, or 10 times the diameter of a hydrogen atom. Changes in

our view of what an organism or species is. Increased interface between machine and biology. "Life forms are being reduced to molecular codes. The code of a person's DNA or a deadly virus could be sent as an attachment to an email message, and recreated in a lab. Human-machine integration isn't just fiction anymore. Teams at MIT, Xerox and elsewhere are racing to connect you very closely to your cell phone and television. Within a few years, pacemakers and other medical devices will begin corresponding electronically with hospitals, physicians, and even insurance companies about the patients whom they 'inhabit'. Many aspects of our behavior will be monitored more closely, and we may even get insurance discounts if we agree to 'show' what healthy people we are."
Sources:
Institute of Nanotechnology website, accessed 9/9/2005
http://www.nano.org.uk/nano.htm
Glenn McGee, Associate Director of the University of Pennsylvania's Center for Bioethics.

F112 There is increased reliance on bond market and transaction taxes (sales tax, vat) as a revenue source for the Federal government.
More government funds will be derived from these sources vs. income tax.
There will be a blurring of ideologies of those favoring taxes vs. lowering taxes as reality sets in that basic commodities (e.g., gasoline, cigarettes) must be taxed to raise revenues for basic public services.

F113 Types of cargo moving on the inland waterway system change from bulk items like grain, coal, petroleum products to automobiles and trucks that roll on and roll off barges, transferring from highway to waterway and back.
New types of cargo could revitalize the inland waterway system, creating a greater need for a safe, reliable system. Size of containers may affect size of vessels.

F114 The supply and demand for oil and the price of gasoline creates pressure to accelerate development of alternative fuel sources (i.e. fuel cells).
This could stimulate renewed concerns about energy efficiency, and perhaps a revitalization of water transportation.

F115 There is high economic growth in Asia-Pacific continent, especially China and India.
High technology and low wages of China and India are making these countries giants of world trade. U.S. trade imbalance is increasing, with imports from Asia skyrocketing. If current trends continue, China will become largest economy in the world. High growth rates in developing countries also create huge demands for resources, especially raw materials like steel, oil.

F116 There is a growing trend in many economic sectors both nationally and internationally for pricing and other demand management measures to promote efficient use of existing facilities and reduce the demand for new infrastructure investments.
Sources:

http://www.environmentaldefense.org/documents/4592_MissRiverBoondoggle.doc
http://tmi.cob.fsu.edu/act/publications/Resource_Manual_09.17.04.pdf
http://www.idrc.ca/en/ev-57064-201-1-DO_TOPIC.html
http://www.manugistics.com/solutions/drm_dm.aspx

F117 Water quality does not meet standards.
According to EPA's 2000 National Water Quality Inventory, 40% of streams, 45% of lakes, and 50% of estuaries that were assessed were not clean enough to support uses such as fishing and swimming because of impairment from bacteria, nutrients, metals (primarily mercury), siltation, runoff from agricultural lands, municipal point sources (sewage treatment plants), and hydrologic modifications (such as channelization, flow regulation, and dredging). Water quality may limit or curtail some multiple uses, particularly water supply and recreational use. Water quality may also limit dredging operations and flow regulation in water systems. This could increase conflicts over water use.

F118 The impacts of major disasters (earthquakes, floods, hurricanes, forest fires) on urban areas increase.
Federal government authorities are tasked to evaluate disaster risks of all water resource structures, dams and Federal facilities (e.g., earthquake safety).

F119 Project decisions continue to rely primarily on economic benefits due to difficulties with the quantification and monetization of environmental benefits.
Unless environmental benefits can be credibly quantified and monetized, they will receive less attention in the budget.

F120 Downsizing of the Federal government will place greater emphasis on non-Federal participation and privatization for Federal spending.
Downsizing can also lead to the inability of each district to maintain 100% expertise in all areas. A collaborative work environment within and without the agency will be needed. Thus, government agencies need to move to the "networked" model of public governance in which core competencies are developed collaboratively with other Federal agencies.

F121 Support for a national water resources program will decrease in the absence of clear emphasis by the Administration, Congress, or the public.
Water resources, being a discretionary spending program, will be a back-burner issue. Without a clear message about faltering or at-risk infrastructure that the public understands and accepts, public agencies that the deal with water resources issues will rely on the whims of a disinterested Congress and administration – unless there is an emergency. Smaller proportion allocated to public water resources and related infrastructure programs as a general budget item. Emergencies can increase supplemental budgets, which may increase roles and responsibilities of the federal authorities that deal with water and related resources issues.
Sources: The American Rivers homepage on USACE Reform is at:
http://www.americanrivers.org/site/PageServer?pagename+AMR_CitizensGuide

An objective analysis of the USACE program by the CRS is contained at:
http://www.fas.org/sgp/crs/natsec/IB10120.pdf

F122 There is a decline in influence of the water resources lobby.
There is less funding for water resources projects.

F123 The nation's water resources infrastructure continues to age and becomes more vulnerable to various types of failure.
There is decreased reliability of the navigation system, hydroelectric power generation system, flood control system. Catastrophic dam failure or contamination of water supply could result in significant economic impact and risk to public health.

F124 There is increased use of the military for contingency operations, terrorism, flood relief, emergency management.
Expanded military role may usurp the military's role in flood fighting and emergency response to FEMA or add manpower for critical response and recovery mission accomplishment.

Strategic Factors Survey Instructions

Instructions for Rating Strategic Factors

The attached files contain a survey of strategic factors and an accompanying clarification of each statement. The factors may have an impact on organizations that deal with the future of water resources and infrastructure in the U.S. between now and the year 2035. The factors will be used in the development of alternative future scenarios during the Scenario-based Strategic Planning training session on 31 Oct – 3 Nov at the Casey Building, Alexandria, VA.

We would like your input on the *likelihood* and ***relative importance*** of these factors to organizations involved in water resources and related infrastructure. Each factor is stated in the form of a proposition that may or may not be true by 2035. We request your opinion about the likelihood that the proposition is in fact true by 2035 and also your view about its importance to providers of water resources if it were true.

Tasks:

1. **PLEASE REVIEW THE ENTIRE SET OF FACTORS AND THEIR DESCRIPTIONS BEFORE RATING EACH FACTOR.**
2. We have set up an electronic survey as a form in MS Word attached to this e-mail. Open the "Strategic Factors Survey" form to score each statement on likelihood and importance, ensuring to provide your name and organization. The second file ("Factors Descriptions") describes each statement and may suggest its possible outcomes; use it as a reference when scoring the Strategic Factors Survey.
3. The first "field" is for your name. The field will expand as you type in your whole name. The second field is for your organization; select the option from the drop-down menu that represents your organizational element.
4. Each factor is presented as a statement or proposition. Evaluate each statement using a drop-down menu in terms of the scales described below. Select that number which corresponds closest to your personal assessment of the likelihood of the statement being true in column 1 between now and 2035 and its relative importance in column 2. An example is provided below.

Likelihood	**Importance**
How likely is it that by the year 2035 the statement is true?	How important is it to future water resources and infrastructure if the statement were true?
5 = Very likely	5 = Very important
4 = Somewhat likely	4 = Somewhat important
3 = Neither likely nor unlikely	3 = Neither important nor unimportant
2 = Somewhat unlikely	2 = Somewhat unimportant
1 = Very unlikely	1 = Very unimportant

Sample

F14. Many states are focusing on Brownfields. Brownfields cleanup will be emphasized more in 2035. Likelihood = **2** Importance = **4**

In this example, this hypothetical person answered "2" for likelihood and "4" for importance, thus expressing the belief that it is somewhat unlikely (not true) that Brownfields will be an issue emphasized in 2035 but also indicating that it is somewhat important factor to the future of water resources in terms of its impact if the proposition were true in 2035.

5. **IT IS IMPORTANT THAT YOU SCORE EVERY STATEMENT**.
6. When you have completed this evaluation, please send your data to Ms. Anne Sudar, IWR -- R.Anne.Sudar@usace.army.mil **SUSPENSE: 26 October** so that we can conduct the appropriate analysis in time for the training session scheduled for beginning Oct 31st.

If you have questions about this task, please contact Anne Sudar (IWR) at 703 428-7166 or Donna Ayres (IWR) at 703 428-6291.

Thank you for completing this task.

Results of the survey are shown below in Table 1. The 'F' numbers refer to the Factor list above which contains explanations of each factor.

Table 1. External Factors With Potential to Impact Water Resources in the U.S., Evaluated as to both Likelihood and Importance (sorted by importance)

Factor	Likelihood	Importance
F123 The nation's water resources infrastructure continues to age and becomes more vulnerable to various types of failure.	4.6	5.0
F96 Water becomes a scarce resource in many parts of the U.S. (and the world), increasing the potential for conflicts over water use for human consumption, agriculture, industry, power generation, recreation, navigation, flood control, and habitat for fish and wildlife.	4.4	4.9
F17 Inter-state political squabbles increase as water resource issues are stressed through competition for water.	4.4	4.7
F15 Human activities continue to degrade and alter the ecosystem.	4.1	4.7
F121 Support for a national water resources program will decrease in the absence of clear emphasis by the Administration, Congress, or the public.	3.3	4.7
F1 U.S. population is increasingly urbanized, concentrated in large megalopolises	4.4	4.6
F84 Attitudes toward human and environmental health positively affect the funding for safe water supplies, municipal wastewater treatment systems, cleanup of contaminated waste sites, ecosystem restoration, protection of endangered species and their habitat.	3.9	4.6
F22 Water problems are increased in complexity (scope and scale), as characterized by multiple stakeholders, conflicting objectives, high levels of uncertainty as to measures and their effectiveness. The complexity of water problems increases at a greater rate than confidence in our ability to solve these complex problems.	3.9	4.6
F95 Water markets based on water rights and water transfers will be used to meet increasing high-value demands such as domestic water supply.	3.8	4.6

Factor	Likelihood	Importance
F24 Attitudes toward public water management shift from a proponency for control to a proponency for sustainability, i.e., from structural to nonstructural solutions to water resource problems.	3.3	4.6
F75 The incidence and severity of storms and natural disasters increases.	4.0	4.6
F9 Cargo flows into and out of ports increase dramatically.	3.9	4.6
F51 The Federal budget for water resources is reduced given warfighting requirements, increases in entitlement programs, and deficit spending.	3.9	4.6
F10 The U.S. economy declines due to triggers and external shocks such as rapid escalation of oil prices, a large-scale environmental disaster, collapse of international financial markets, and sudden withdrawal of foreign capital from the U.S.	3.4	4.6
F122 There is a decline in influence of the water resources lobby.	2.3	4.6
F54 The climate changes globally as witnessed by a rise in land and ocean temperatures, increases in sea level, melting of permafrost, more extreme precipitation events, etc.	4.2	4.4
F64 The U.S. Population continues to migrate to the South and West Regions (arid areas).	3.9	4.4
F104 Localities with sufficient water resources/resources will seek to control more or all aspects of water infrastructure and consumption. Localities without sufficient water sources/resources will look to state and Federal governments and the courts to acquire water sources/resources.	3.9	4.4
F63 People keep moving to coastal areas, particularly in the South and Southeast where there is high incidence of hurricanes, increasing human and property vulnerability to wind and flood damages, even loss of life.	3.8	4.4
F117 Water quality does not meet standards.	3.7	4.4
F118 The impacts of major disasters (earthquakes, floods, hurricanes, forest fires) on urban areas increase.	4.3	4.4
F50 Economic losses associated with natural disasters will grow as the incidence and scope of disasters increases.	4.2	4.4

Factor	Likelihood	Importance
F42 People migrate from the water-rich areas of the north and east in the U.S. to the water-short areas of the south and west.	3.6	4.4
F34 Biodiversity declines as more species become extinct. The single biggest threat to species survival is loss of habitat.	4.3	4.3
F13 Loss of wetlands continues, but at a slower rate than in the recent past.	3.6	4.3
F52 U.S. budget deficit continues to increase.	3.6	4.3
F35 The amount of money invested by both government and private sector in environmental protection and improvement programs increases.	3.0	4.3
F58 There is continuation of a trend toward erosion of the non-Federal share in Federal water projects since the passage of the Water Resources Development Act of 1986, as evidenced by an ever-increasing list of exemptions and exceptions from cost-sharing in subsequent legislation.	3.0	4.3
F74 Container ships increase in size and require deeper channels.	3.8	4.3
F76 New exotic species will be introduced into America's lakes and rivers, and those already present will expand their range.	3.7	4.3
F11 The percentage of the U.S. Gross National Product (GNP) spent on defense increases because of the Global War on Terror.	3.7	4.3
F71 Levels of Traffic on the Marine Transportation System remain static.	2.4	4.3
F21 World population will continue to increase, although rates of change will vary geographically, with higher growth in the developing countries.	4.8	4.2
F116 There is a growing trend in many economic sectors both nationally and internationally for pricing and other demand management measures to promote efficient use of existing facilities and reduce the demand for new infrastructure investments.	3.7	4.2
F33 The pattern and type of agricultural activity shifts, affecting the need for irrigation, the need for transport of crops to markets, and demand for water resources and related infrastructure.	3.6	4.2

Factor	Likelihood	Importance
F53 The amount of freight needing to be moved in the U.S. will increase dramatically.	3.4	4.2
F119 Project decisions continue to rely primarily on economic benefits due to difficulties with the quantification and monetization of environmental benefits.	3.1	4.2
F80 As the relative portion of population increases in coastal areas, the political influence of coastal residents and coastal states will increase also.	3.8	4.1
F79 There is more innovative financing of public infrastructure, e.g., mixed combinations of financing, such as a) greater share of state funding and lesser share of Federal appropriations; b) greater share to private entities and state/local authorities and a lesser share of funding to the Federal government.	3.7	4.1
F107 Models based on consensus building are increasingly used for planning as contrasted with the rational optimization model reflected in Federal planning guidelines and underlying the Federal budgeting process.	3.7	4.1
F38 The courts are increasingly used to resolve water conflicts.	3.8	4.1
F120 Downsizing of the Federal government will place greater emphasis on non-Federal participation and privatization for Federal spending.	3.7	4.1
F68 Expanded use of complex interactive computer models makes reproducing and evaluating real-world situations easier.	4.1	4.0
F98 As environmental knowledge grows, even more questions and uncertainties regarding environmental systems are revealed.	4.1	4.0
F16 There is more downsizing, privatization, and outsourcing of Federal roles.	3.4	4.0
F105 Scandals, the results of USACE studies, and complaints about project processes damage the reputation and public trust of the USACE.	3.4	4.0
F85 Much of the immigration from Latin America to U.S. settles in the South and West (arid regions).	3.8	3.9

Factor	Likelihood	Importance
F86 Voter preferences for environmental protection/restoration of natural resources and services and the development of environmental and human resources contribute to determining the pace of public investment in natural resources management and the environment.	3.8	3.9
F99 The accountability movement leads to increased public scrutiny of public policy and political decision making.	3.6	3.9
F113 Types of cargo moving on the inland waterway system change from bulk items like grain, coal, petroleum products to automobiles and trucks that roll on and roll off barges, transferring from highway to waterway and back.	2.9	3.9
F6 Electronic measuring devices make it easier to measure vessel tonnage (displacements) and movements of vessels.	4.6	3.9
F27 Technology (e.g., new survey equipment; remote sensing, GPS) has greatly enhanced our ability to image and characterize the physical world, making it easier to acquire field data.	4.6	3.9
F30 Trade will continue to increase rapidly with the Pacific Rim countries, particularly China.	4.1	3.9
F19 Some regional power or non-state actors will use nuclear power/weapons.	3.7	3.8
F3 There is a diffusion of centralized authority as competency and advocacy increase among local and grass roots entities.	3.2	3.8
F25 Ever faster and better information and communication technologies pervade every aspect of our society.	4.8	3.8
F29 There will be economic expansion and increasing productivity in Latin American countries.	3.8	3.8
F40 Global calamities (natural and manmade disasters such as nuclear accidents like Chernobyl, oil spills, and geological eruptions) incur prolonged and extended impacts which lead to political and social turmoil and global instability.	3.6	3.8
F59 Agricultural interests lose their influence in Congress as compared to the influence of urban interests.	2.9	3.8

Factor	Likelihood	Importance
F94 Economic and political trends will shift power, influence, and programs away from the Federal government toward state, local, regional, and private sectors.	2.9	3.8
F12 There is a decline of government bureaucracies, a shift from Central Planning to Market Systems in the world.	2.9	3.8
F103 There is continued emphasis on homeland security; more public attention to security issues.	4.1	3.7
F101 There is increasing pressure to use grants and incentives vs. direct government services.	3.6	3.7
F36 Regional conflicts and war in the Middle East, South Asia, Baltic States, China, Near East Asia, Southern Hemisphere of the Americas are a threat to the U.S.	3.9	3.6
F73 The level of consumer, business, and government debt increases.	3.8	3.6
F55 Fossil fuels do not keep pace with demand, and use of alternative energy sources increase dramatically.	3.7	3.6
F83 Public trust in government institutions declines and many citizens believe that government programs are unresponsive and duplicative.	3.7	3.6
F77 There is no agreement about what "environmental restoration" means.	3.2	3.6
F18 Government becomes more business-like and business becomes more conscious about public policy issues.	3.2	3.6
F62 Decentralization of many programs to lower levels of government becomes a major focal point in many governments.	3.0	3.6
F93 As Third World countries become developed and the populations become educated, and as capital flows into them to take advantage of low labor rates, the demand of these populations for goods and services will accelerate.	4.2	3.6
F41 The balance of Federal, State, and local roles related to infrastructure security shifts as infrastructure security demands rise.	3.4	3.6
F14 Brownfields cleanup receives more emphasis.	3.3	3.6
F7 As technological change accelerates, so will the rate of technological obsolescence.	4.3	3.5

Factor	Likelihood	Importance
F26 U.S. leadership in science and technology wanes, as evidenced by the fact that many American goods retain a stigma of poor quality and even worse servicing.	3.7	3.5
F72 There is increased dependence on the private sector to support services traditionally provided by the government.	3.6	3.5
F102 Nuclear, chemical, and biological weapons are easier to obtain, and reach the hands of non-state actors and hostile third world countries.	3.6	3.5
F97 Seemingly benign human activities, such as generation of nuclear power, are found to cause human health and ecological damage.	3.2	3.5
F23 There will be increasingly decentralized decision-making systems, with power originating from many sources because of the proliferation of fast, flexible, decentralized information technology tools.	3.1	3.5
F115 There is high economic growth in Asia-Pacific continent, especially China and India.	4.2	3.4
F92 Economic productivity will continue to increase.	3.7	3.4
F43 The Baby Boom and the Aging of America; Baby Boomers have reached retirement age, and people are living longer and having fewer children, resulting in a lot more older people in the U.S. and less younger people to support them.	4.7	3.4
F89 Advances in artificial intelligence will change the way in which computers process information, with machine intelligence that can augment and mimic human intelligence through perception, learning, induction, deduction, and discovery, affecting real-time control and self-diagnostic and self-repairing systems.	4.1	3.4
F44 The workplace creates jobs that demand higher skills than the labor pool can meet.	3.5	3.3
F82 Conflicts over water help countries and regions resolve other conflicts.	2.7	3.3
F114 The supply and demand for oil and the price of gasoline creates pressure to accelerate development of alternative fuel sources (i.e. fuel cells).	4.6	3.3
F110 With increasing public access to government information, government workers will operate in a fish bowl, i.e., demands for transparency will increase.	3.6	3.3

Factor	Likelihood	Importance
F66 The middle class in the U.S. shrinks, as more slip into poverty.	3.2	3.3
F88 Robotics are rapidly advancing.	4.3	3.2
F8 The Sub-Saharan African economy remains devastated and poverty persists in this part of the world.	4.2	3.2
F57 Interdependence among the major nations increases due to globalization of finance, trade, economics, telecommunications, politics, thus diminishing the sovereign power of individual nations.	3.8	3.2
F37 There is a re-sizing of the Federal workforce and overhaul of the Civil Service laws with respect to GS ratings, performance appraisals, RIF procedures underway.	4.0	3.2
F20 Politicians will continue to use their influence to bring homeland security funds to their home districts.	4.3	3.1
F31 The disparity between the "haves" (e.g., northern hemisphere countries) and the "have-nots" (e.g., southern hemisphere countries) will fuel global unrest.	3.2	3.1
F87 The two major political parties in the U.S. are clearly divided along ideological lines, and there is a lack of willingness to compromise on principles. Each "camp" believes in its fundamental world-view. There will be continued polarization of political ideology (Red State vs. Blue State mentality).	3.2	3.1
F65 There is increased real-time distribution, availability, and access to information through the mass media.	4.5	3.1
F56 There is increased development and use of conservation and energy efficiency standards in design of buildings.	4.1	3.1
F124 There is increased use of the military for contingency operations, terrorism, flood relief, emergency management.	4.0	3.1
F69 As technology advances and societies become more refined and their activities more elaborate, their members become more deeply reliant on external systems and services.	3.8	3.1
F2 The concept of "office" has changed to accommodate the needs and desires of workers to a greater degree, allowing for virtual work from home or elsewhere outside the office and across time zones.	3.6	3.1

Factor	Likelihood	Importance
F60 There is increasing tension between Federalism and State rights given an expanded Federal role in standard setting, e.g., in education, the "no child left behind" standards.	3.2	3.1
F108 There is a growing global interdependency of markets and labor forces.	4.3	3.0
F28 Although new technologies such as the Internet, satellites, nanotechnology, biometrics, radio frequency identification, and DNA analysis have many benefits for society, their acceptance and implementation is hindered by concerns over the erosion of personal privacy.	3.8	3.0
F70 The U.S. shifts to a service-based economy focused on ideas and knowledge, one that involves different skill sets than those required by the previous manufacturing-based system.	3.8	3.0
F61 The rise of political Islam continues, due to youth bulges in Arab countries, unemployment, and the effects of orthodox religious education (fundamentalism).	3.8	2.9
F48 There will be more demands to maintain technical capability, causing a greater percentage of workers' time to be spent on training in the future.	3.7	2.9
F81 The boundaries between war, civil unrest, terrorism, and crime are increasingly blurred.	3.7	2.9
F78 Technologies of the Information Age, combined with decentralization and the rise of market economies, place more freedom of choice and power in the hands of smaller groups and individuals than ever before.	3.6	2.9
F32 Native American corporations become a viable economic unit due to casino revenue. Many Native American corporations invest their revenue into community action programs and infrastructure development.	3.3	2.9
F109 Despite the fact that the technology for genetically engineered or transgenic crops is improving, support for using it does not materialize.	3.1	2.9
F49 Changes in internal combustion engines and how we use fuels, the fuels we use, hybrid cars, fuel cells, nuclear technologies will lead to changes from highways to skyways and smart highways, where people can sleep on the way to work and cars drive themselves for personal transportation.	2.9	2.8

Factor	Likelihood	Importance
F5 There will be increased use of instant wireless communications (e.g., blackberries, teleconferencing) to facilitate telework and long-distance teaming, collaboration, and learning.	4.8	2.8
F106 Cultural and Ethnic Diversity in the Population of the U.S., and the U.S. Public Sector Workforce increases.	4.4	2.8
F4 There is a polarization of views taking place, reflecting increased fundamentalist thinking.	3.0	2.8
F47 Advancing frontiers in biotechnology, especially genetic engineering, such as bioremediation methods for in-situ, cost-effective environmental cleanup, materials science, biological creation of high-performance polymers, advances in gene therapy, advances in cloning offer both bright promise and potential threat, as the very building blocks of life are manipulated to search for solutions to a broad spectrum of problems.	4.3	2.7
F67 There is a shift from Newtonian physics (equilibrium, cause and effect predictability, the more you study a system the more you can understand it) to biology (nondeterministic, dynamic systems, hard to predict where it is going) as a dominant paradigm in the U.S.	2.8	2.7
F46 Computers as we know them today will become invisible, literally absorbed into their surroundings and embedded in walls, carpets, toasters, neckties, and even our own bodies.	3.4	2.7
F90 Human skills such as caring, judgment, intuition, ethics, inspiration, friendliness, and imagination that cannot be automated will become more important and valued.	3.1	2.7
F112 There is increased reliance on bond market and transaction taxes (sales tax, vat) as a revenue source for the Federal government.	3.1	2.7
F111 As computer equipment, surgical tools, and communications pipelines shrink ever smaller with the advent of nanotechnology, the next step in engineering is to merge biological and mechanical molecules and compounds into really, really small machines.	3.8	2.6
F39 Public confidence in the U.S. military increases because the military is seen as a can-do organization.	3.2	2.4

Factor	Likelihood	Importance
F45 Religious beliefs have more impact on public policymaking.	2.9	2.4
F100 There is more integration and "jointness" (Purple Suits) among the armed forces.	3.4	2.2
F91 America is a cashless society where nearly all money moves electronically.	3.7	1.9

Appendix B Uncertainty Descriptions

Descriptions of the uncertainties and polarities were adapted from a report prepared for USACE Civil Works Directorate by the contractor (Decision Strategies International, Inc. 2006).

Uncertainty U1—What is the socio-political context during disasters and catastrophic events by the year 2035?

This uncertainty is about the boundaries between social chaos and stability, between institutional capability and disintegration. Natural and man-made disasters test the ability of public and private institutions to restore necessary services, including infrastructure and water supply. They threaten social stability, and challenge government, the private sector, and NGOs to develop plans to reduce suffering and ensure the continuation and coordination of vital private and governmental organizations and services. The capability of the financial sector to support aid and relief efforts is a paramount concern.

Polarity U1A—Harmonious and unified

Government responds quickly and efficiently to restore social order, governmental institutions, and a functioning infrastructure. Coordination with NGOs and the private sector is efficient and significantly enhances the disaster response. Plans prepared well beforehand fully anticipate requirements and provide guidance that is thoroughly understood and supported. The American public views major disasters as national disasters, not just regional, which therefore require responses from federal agencies and possibly temporary tax increases. Whenever necessary, ad hoc intergovernmental arrangements are established to ensure that relief is provided until the affected area obtains services and institutions equal or nearly equal to pre-disaster conditions. Optimism reigns.

Polarity U1B—Fibrillating and chaotic

Chaos reigns. Basic social needs are not met, and the social order collapses. The government is paralyzed, without adequate plans and is ripped apart by bureaucratic rivalries, political squabbles, and inadequate resources. The infrastructure is demolished, including water distribution, flood control, and electric service. The private sector either has no capability to provide relief or does not know how to provide it in the face of government's inability to provide guidance. In some cases, ecological disasters abound, including the destruction of wetlands (and threats to biological diversity), degraded air and water quality, toxic poisoning on land and water, and sediment-laden rivers and reservoirs. Earthquakes, hurricanes, and other disasters create havoc. Social conventions are forgotten, and a suffering public ignores all laws in attempts to find food and shelter. Particularly in the face of terrorist activities, rumors are everywhere and no one knows whom to trust. Devastation is everywhere, and deep pessimism permeates society.

Uncertainty U2—What are the roles and responsibilities for water resources management by the year 2035?

Who does what in water management is an important and controversial issue, especially as the increasing and conflicting demands on water supplies stress the adaptive capacity of individuals and institutions (T4). Large metropolitan areas force innovative solutions and political negotiation (T3) with each other, with the agricultural sector and, in the West, with Native Americans. Given the large infrastructure and public school construction claims on local budgets, the result of increased urban population, private sector ownership of water systems appeals to some localities. Conversely, others seek more help from state and federal agencies. Coordination among all three levels of government—local, state, and national—remains an ongoing issue and exacerbates inefficiencies. Boundaries of power and authority shift back and forth in accordance with court decisions and administrative fiat. Water agencies at all levels of government may find it difficult to reconcile efficient water delivery and/or flood control and hydropower requirements with environmental protection. Traditional benefit-cost analysis is controversial, but risk and vulnerability analyses appear arbitrary and capricious or are non-existent. Moreover, agencies may disagree on the quantity and quality of the data being used. In short, different definitions result in conflicting conclusions about the social equity and economic efficiency of projects and government policies. The consolidation of federal water resource agencies is considered in both Congress and the bureaucratic hallways of the Executive Branch. The federal structure of the United States ensures continued overlap of responsibilities and ongoing competition and cooperation among water management agencies at all levels of government.

Polarity U2A—Local and fragmented

Many federal water resources functions are eliminated or reduced in scope, partly the result of judicial decisions that significantly limit federal involvement in water management. State and local agencies pick up some of the responsibilities, but many are left to the private sector and NGOs. Still, water management is fully responsive to existing federal policies even if left to non-federal and private agencies to implement. Most new construction is left to non-federal offices. Water bills and local and state taxes increase sharply, and the price of water becomes a significant issue for businesses and individuals wishing to relocate. Access to water is secure but more expensive than ever.

Polarity U2B—Federal and integrated

The federal government assumes most water management functions, which are consolidated and coordinated. States and localities challenge federal dominance, and many believe that federal management has resulted in inequitable and wasteful projects, partly the result of the congressional pork barrel and partly the result of planning procedures thought to be inaccurate or biased. Localities seek more control of their water infrastructure, which often means conflict with neighboring jurisdictions that may share in the cost (and benefits) of the water infrastructure. Inter-basin transfers of water are particularly contentious. The courts are swamped with suits lodged by large and

growing cities against farmers and Native Americans in attempts to break former agreements and treaties. The federal government is mired in countless legal actions and contentious political contests.

Uncertainty U3—Will there be sufficient funding for water resources infrastructure?

Is there going to be enough money and how shall it be raised are the principal questions in this uncertainty. Without it, uncertainties U1, U2, and U4 clearly point in a downward direction. Infrastructure construction and maintenance draws on discretionary funding and must compete with many other claims on local, state, and federal budgets. Discretionary funds also face possible reductions resulting from growing entitlement programs and defense needs. Answers to the funding problem span a wide range of possibilities, from increases in taxes and tariffs to joint public-private investment partnerships to bond sales in support of infrastructure projects. Governments face the prospect of turning over existing and planned infrastructure projects to the private sector in the face of mounting financial hardship. Competing budgetary demands and limited resources threaten necessary construction, operations, and maintenance in the absence of new approaches and solutions.

Polarity U3A—Sufficient funding for water resources

Funding for water infrastructure comes from a reallocation of federal discretionary funds and from innovative financing, including mixed public-private investment and cost sharing with states and localities. The federal government, and possibly even private interests, is also able to provide grants to non-federal interests. States and localities capable of overseeing construction and operation of projects do so, although some level of federal funding continues. At all levels of government, new taxes, bond issues, and user fees are instituted to support infrastructure projects. A growing public willingness to pay market prices for water also provides the means for necessary construction and maintenance.

Polarity U3B—Insufficient funding for water resources

Federal deficit and debt increases, mainly the result of the growth of entitlement programs and defense expenditures. Congress neither has the will nor the way to finance water resources infrastructure construction and maintenance, and repairs and replacement are postponed or eliminated. There is substantially less money than required to fund construction, and stakeholders and government agencies at all levels compete for scarce dollars. The inland waterways fuel tax is increased, but still does not cover the revenue requirements. Non-federal interests attempt to compensate for the loss of federal dollars. The barge industry and various shippers pay for some necessary improvements, and some lock and dam operations are privatized. Generally, the water resources infrastructure suffers degradation and threatens regional and national economies.

Uncertainty U4—Is water infrastructure adequate to satisfy multiple social demands in 2035?

A healthy nation must have clean pipes of sufficient quantity to convey potable water and to drain wastewater. The pipes, and all other aspects of the water infrastructure, must be expanded as the nation's population grows. The water infrastructure needs to be managed and maintained to extend its longevity and provide flexibility to meet the multiple demands of a growing population. New uses of water (i.e., ethanol production) must be addressed. Demographic shifts that result in more urbanization require new water supply and stormwater systems, as well as recreational facilities. Funding is always an issue (U3). Technological developments, such as desalinization plants and improved irrigation techniques, help provide more water, more efficiently, to urban areas and enhance conservation efforts. The health of the infrastructure very much depends on the ability of politicians to work together to improve water use efficiency and distribution among several political entities (U11).

Polarity U4A—Infrastructure fully satisfies social demands

With sufficient funding and political will, existing infrastructure has been upgraded where necessary and additional facilities have been created to fulfill needs in the year 2035. Underground reservoirs have added to storage capacity. Desalinization plants along the West Coast supplement traditional water supplies during drought or heavy use. Irrigation channels have been lined to prevent water loss. Integrated water resources management within and between regions, states, and towns has led to a variety of joint infrastructure projects to increase water availability. Pipelines transport water from Canada to portions of the West. Water is sold subject to the NAFTA agreement. More Quebec hydropower is sold to New England.

Ports are modernized to meet the requirements of modern containerships and bulk cargo carriers. Port operations are fully automated. Information technology will allow freight handlers and distributors to mark where and when a container should be loaded and when it should arrive at its destination, eliminating storage needs while promoting seamless transfer of containers across transportation modes. The use of low cost GPS will also improve tracking operations. Dredging is an ongoing requirement, and steps are taken to ensure that dredging can proceed without causing significant environmental damage.

Polarity U4B—Infrastructure is inadequate for demands

The water infrastructure is unable to supply sufficient water or clean potable water. Social and political conflict, including congressional gridlock, prevents the development of plans to ensure adequate infrastructure. Budgetary constraints result in poor and unreliable maintenance. There is insufficient investment in new technologies to conserve water and insufficient political will to impose conservation measures. Old infrastructure is constantly failing, and lack of sufficient inspections puts people at risk from leaking dams and from contaminated water distributed from "treatment" plants.

Public health hazards increase because of the biological and chemical contamination. Groundwater pumping is common, but it often leads to law suits over prior use and water rights.

Crumbling locks imperil inland waterways transportation, and inadequate dredging forces closure of certain ports. Reservoirs full of sediment can no longer hold sufficient water for municipal and industrial needs, or provide flood storage. The sediment threatens fish and wildlife and discourages recreation use. Every extreme hydrologic event worsens conditions and exposes more problems. Gripped by political paralysis, inadequate funds, and worsening climatic conditions, the country is overwhelmed and can do little to respond to its infrastructure problems.

Uncertainty U5—To what extent will fossil fuels satisfy U.S. energy needs?

Growing demands for energy, combined with concerns about environmental degradation and diminishing natural resources, challenge energy planners in the year 2035. Fossil fuel remains the major energy source, but technological breakthroughs may result in consideration of hydrogen fuel cells, biomass fuels, and wind, solar, and geothermal power as alternatives for fossil fuels. Conservation is another way of promoting energy efficiency, and urban planners work to make cities more habitable, which generally mean reducing car traffic and turning parking lots into people parks. Consumers find ways to reuse cooking oil and garbage as fuels and are receptive to other innovations. The energy picture can be swiftly altered through economic recession or global disruptions of oil and natural gas. Competing demands for water reduce the amount available for hydropower. Energy production increases, but so does its price as private companies pass on their research and development costs. This is an age of energy winners or losers, both nationally and globally.

Polarity U5A—Alternative sources and new technologies become significant

Americans are both innovative and conservation-minded, producing the luxury of energy independence and, consequently, enormous deficit reduction. Wind generated electricity is used to produce hydrogen, which runs back-up generators when the wind power declines. Hydrogen fuel cells, solar photovoltaic cells, and gas-hybrid engines are all common and have dropped in price. Some nuclear plants are on-line. Tidal and geothermal energy provide a small percentage of America's needs overall, but geothermal energy has become an important source of energy in the American West. Automobile gasoline consumption drops drastically. The federal government subsidizes research on alternative fuel technologies, and governments at all levels use regulations and tax incentives to assure energy efficiency through conservation. There is enough available water to produce hydropower, although hydropower diminishes as a percentage of U.S. energy production and is subject to numerous environmental regulations regarding instream flows. U.S. energy independence promises good times ahead.

Polarity U5B—Fossil fuels remain dominant

Lack of government funding and incentives, technological "break-throughs" that either proved unreliable or too expensive, and general public disinterest cause a decline in research and development of alternative energy sources. Global competition for fossil fuels reduces the amount and raises the cost of petroleum available to the United States. A largely urban population demands water for municipal and industrial use and reduces the amount available for other purposes, including hydropower. Continued dependence on foreign oil and limited fossil fuels available in this country adversely affects economic growth. The quality of life declines.

Uncertainty U6—How will international markets and economic agendas affect U. S. water resources management?

The future of globalization is at the heart of this uncertainty. The world may continue on a path towards free markets, democratic governments, and transparency. Information, goods, and services may flow freely, and people may easily cross borders, seeking education, work, or a better quality of life. Interconnected world-wide virtual engineering offices will use common software to design public works projects. Alternatively, decreased support of globalization leads to reinvigorated nation-states and regional alliances, or, far more suddenly, war or a pandemic could spell the end of globalization. Whatever happens, the United States will be affected. Should the U. S. turn to a more isolationist posture, there may be an impact on water availability (especially, "virtual water") and on opportunities for civil engineers. Will an interdependent world use not only its natural resources wisely but also its people resources, or will economic recession, disintegrating institutions, and international conflict consign engineers to purely domestic work. Can virtual offices puncture holes in immigration and trade barriers and keep the information flow going?

Polarity U6A—Globalization, interdependence, and cooperation

The world is becoming evermore interdependent. Trade barriers fall, and international trade flourishes. Visas are either easy to obtain or entirely eliminated, and it is common to find engineers from many different countries sharing work on the same project. Consortia of international financial institutions finance many of these projects. Technological transfer is common, although patent laws, subject to World Trade Organization regulations, allow inventors to retain a share of proceeds for a specified number of years. Throughout the world markets are prospering, but most of the increase in consumer demand is taking place in the developing nations, especially China, India, and Indonesia. Companies from these countries have an increasing global impact, and many developing countries demand more leverage in international bodies. Some developing countries lag behind, however, and social inequity and the gap between "haves" and "have-nots" may actually increase.

At the same time, the easy transfer of services, people, and goods stimulates competition, and U. S. construction firms face stiff challenges to their market share. Even in the United States, one finds an increasing number of projects, including those for water resources, built by foreign construction companies using machinery and parts from

many different countries. Outsourcing is common, and certain economic sectors (i.e., the service industries) commonly use workers in India, China, and Southeast Asia to do everything from highly skilled labor to the most menial jobs via the Internet.

Foreign investment in the United States grows, including investment in port development. The growing volume of international trade necessitates increased port capacity and deep draft dredging. Globalization also brings more competitiveness within the international labor force and inadvertently contributes to a conflict between generations as older workers stay on the job and prevent younger workers from advancing.

Cornucopia beckons, but seems ever out of reach for some around the world. The thirst for education and learning, however, and the ease with which it is afforded through the Internet and virtual classrooms, allows those with the passion and interest to advance, thus increasing the pool of highly trained workers.

Polarity U6B—Isolationism, autarchy, and protectionism

Countries are retreating to isolationism. Regional alliances replace international cooperation and openness. Financial institutions drastically reduce overseas investment, causing the collapse of some banks and the weakening of numerous currencies, including the dollar. Protectionism replaces free trade as numerous conflicts threaten to erupt into war. Economic recession follows. National leaders seek revenue from new taxes, tariffs, or any other source, and face tremendous opposition. Many items in the discretionary budget, including water resources, are reduced in scale or eliminated. Foreign workers are no longer welcome, and work overseas is no longer possible. International commerce, including maritime shipping, is drastically reduced. International trade agreements are scuttled or ignored. Corruption and smuggling are everywhere. Any major pandemic will create the conditions for deep and long-lasting economic and political paralysis. Nationalism is on the rise.

Uncertainty U7—What will be the impact of environmental values on land and water resources policies and management by the year 2035?

At least in part, this uncertainty is about our progress—or lack thereof—towards reaching sustainable development. More generally, it is about the ability of the United States to reduce environmental degradation to the absolute minimum while continuing to develop a healthy and growing economy. Sustainable development is defined as meeting the needs of the present without compromising our ability to meet those of future generations. Will the U.S. develop a public works infrastructure that supports sustainability or will it continue to reflect traditional views that nature is to be bent to human needs?

Much of what occurs depends on public perception and education. Should the public favor environmental values, government can be expected to impose regulations and incentives to induce individuals and the private sector to support projects that use

natural systems and non-structural solutions to address multipurpose water use. Historically, the public has been more receptive to these approaches during times of prosperity. Global warming may also induce more consideration for the environment, and technological advances that allow alternative energy sources will stimulate interest in environmentally friendly solutions. A key will be to make such alternative sources both technologically sound and economically feasible.

Environmental values impose constraints on water projects in order to protect natural resources and ecological systems. A key challenge will be to find ways to meet these constraints in ways that are socially and politically acceptable. This may involve cultural shifts and lifestyle changes, as well as technological innovation. It also means that public health menaces not be disproportionately borne on the backs of the poor and inarticulate. This involves careful monitoring of air and water pollution and locating hazardous waste sites away from centers of population. Environmental justice is an issue.

Polarity U7A—Environmental values are the major influence on water policies and projects

Green is not only the color of the dollar; it is the color of official policy. Government, private sector, and NGOs join hands to develop new technologies to minimize environmental damage. Wetlands and headwaters forests are carefully preserved in order to enhance water supply and quality. Public-private investments allow the purchase of environmentally sensitive tracts of land. Wetlands mitigation banks are common—developers obtain credits for preserving wetlands and can use the credits elsewhere where wetlands loss is unavoidable. The government also offers incentives (mainly tax breaks) to offset investment in environmentally friendly projects. Even plans to respond to national emergencies and disasters include substantial deference to environmental considerations. Environmental quality is elevated to the same level as economic development in the water resources planning process, and wherever possible master framework studies are drafted and used to project the future of entire river basins. Urban communities integrate waterfront renewal into projects to restore downtown areas. More open space is preserved and worked into master plans for housing developments. A multitude of laws grant communities standing to sue both government and private firms should their water and air quality be threatened. The result is a dramatic improvement in both air and water quality. Alternative “clean” fuels are used. Government “green” requirements meet broad public consensus.

Polarity U7B—Environmental values are incidental or unimportant in key decisions regarding land/water resources

Economic concerns overshadow environmental considerations. Private firms are reluctant to spend money on environmentally friendly projects, and the government has neither the money nor the political will to invest in such projects. The public’s desire is to construct the most economically efficient project, one that delivers adequate water of acceptable quality at the least cost. Population growth results in many demands for new

infrastructure quickly built. Increasingly, the government (including state governments) exempts construction projects from environmental impact statement (EIS) requirements. These exemptions may also embrace maintenance and operations and the rehabilitation of existing projects. Generally, minorities and the disenfranchised suffer adverse environmental consequences, such as dirty water and air. Public health issues increase, including waterborne diseases. Indiscriminate development costs the nation millions of acres of wetlands. Flood control issues inevitably result in structural answers that threaten instream flows and water quality. National economic development is liberally interpreted to allow for numerous questionable infrastructure projects that contribute only to the gain of local elites. Land and water resources deteriorate.

Uncertainty U8—How will new technologies and engineering practices affect water resources management by the year 2035?

A vast potential exists for new scientific and technological developments to enhance the monitoring of water resources and improve predictability—if only the nation determines to use it. These developments could more thoroughly integrate chemical and biological analysis and increase understanding of contaminant transport and global chemical cycles. More generally, the possibility exists of understanding far better the hydrologic effects of human activity, including the global impacts of water impoundment in reservoirs. Improved sewage treatment plants could return cleaner water to rivers and oceans. Cheaper and more efficient desalinization plants would permit their cost-efficient use to supplement fresh water supplies. Alternative energy sources would reduce dependence on hydropower, although not eliminate it. Efforts to store water in manmade or natural underground reservoirs could mitigate water scarcity, reduce evaporation, eliminate sedimentation problems and generally improve water quality. The use of large water bladders and rubber dams that could quickly be placed along or across rivers might reduce flood damage. Genetically modified organisms (GMOs) could lead to more drought resistant food grains and less need for irrigation water.

Polarity U8A—Revolutionary changes in technologies and engineering practices

Scientific advances and new technology greatly enhance water management. Scientific developments afford a better understanding of the relationship between rainfall composition and the chemistry of soils, ground water, and surface water. Improved measurement of carbon dioxide in soils enhances the ability to study the impacts of global warming and the rates of production and decomposition of humus. Improved analysis of contaminants and sediment transport in ground and surface water increases the ability to monitor potential hazardous waste issues. Studies of the interaction of the hydrologic cycle and global chemical cycles increase our knowledge of the relationship between crucial elements such as carbon and nitrogen and water. Improvements are also made in the scale of three-dimensional drainage networks, increasing the predictive accuracy of models. New empirical research and sophisticated data collection improve the accuracy of non-linear equations, used to describe dynamic process such as rainfall and improve dynamic scaling. Aqueous geochemistry improves our ability to understand the movement of water through soil and rock. Remote sensing tools enable scientists to

understand better the relationship between surface processes and weather and climate. Remote sensing, along with sophisticated, modeling, also contributes to an understanding of how impounded waters affect the hydrological cycle.

Global Positioning Systems (GPS) will enhance navigation safety. Improved communication systems will allow quicker response during emergencies. "Best practices" increasingly embrace conservation and environmental protection. Integrated water resources management exploits isotope tracers to track ground water movement and improve the predictability of floods. Water meters automatically relay monthly reports to a central data collection point. Rubber dams and water bladders are frequently used in place of sand bags during emergency flood operations. Underground reservoirs are used to store water, including potential flood water. Desalinization plants serve as back-up water supply units in coastal cities on the West coast. New turbines that produce more energy are put in place in U.S. dams, eliminating the need to add turbines and generators. The world of water is more closely regulated and better understood than ever before. Hydrology departments spring up in American universities.

Polarity U8B—Incremental changes in technologies and engineering practices

The world of water science and technology stagnates. Twentieth century science and technology dominate, partly the result of lack of investment capital and a feeling that it is enough to "make do" when it comes to water infrastructure issues This indifference is marked in the nation's apathy towards global water issues such as acid rain and toxic wastes in the world's rivers and oceans. Rather than developing new insights about ways to reduce contamination in water and river sediment, the nation continues on the same reactive course it has followed for decades, turning a blind eye to new solutions. First the pollution comes, followed by an expensive clean-up and economic dislocation. Technologies to deal with water problems increasingly appear jerry-rigged—a craftsman's answer without scientific underpinning. Hydrology remains the captive of civil engineering departments in most universities.

Uncertainty U9—What is the vulnerability of water resources infrastructure by the year 2035?

The rise of global terrorism and the threat of global warming combine to test the vulnerability of water resources infrastructure to both natural and man-made disasters. The inability to stop the proliferation of weapons, including nuclear technology, and the ability of modern communications technology to link widespread terrorist cells and disseminate "how to" knowledge about explosives and weaponry makes containment difficult. It appears necessary to armor water infrastructure against both the forces of nature and the forces of evil in ways that would have appeared melodramatic a generation ago. The determination of how to do this and which structures appear most vulnerable generates controversy at all levels of government, especially since budgets seem stressed by multiple demands to meet other legitimate requirements. Answers must be social, technological, and organizational. Management must adjust to new ways of doing work to accommodate security requirements.

The nation's water infrastructure includes its navigation system, municipal and industrial water supply, irrigation, flood control, stormwater management, hydropower, and recreational facilities. Homeland security requirements for protecting each component are necessary; all face the possibility of massive destruction during a natural or man-made disaster. The implications for natural security are serious. Questions abound: What threats appear most likely to happen and to what part of the infrastructure? How well-prepared is the national government and local and state governments to meet disasters? What technological and managerial steps are being developed to help reduce vulnerability? Answers to these questions reflect agency and individual responsibilities.

Polarity U9A—Minimized vulnerability of water resources infrastructure

There is close coordination among local, state, and federal governments. The nation's inland navigation and port system is monitored 24/7 to provide real-time reports and help ensure rapid response and recovery from disruptions. Working with public and private sector partners, new technologies are rapidly deployed to increase the efficiency of all components of the infrastructure system. Technical assistance is provided to localities. Threat information is rapidly disseminated to suspected targeted facilities. The national economic significance of federal water infrastructure facilities is prioritized, and Federal water agencies work with the Department of Homeland Security and local and state officials to develop plans to protect the most significant infrastructure. Plans are periodically updated. There is planning for heightened use of waterways should highways and rail transportation be incapacitated, and planning for emergency diversion of water supplies, including interbasin diversions, should water supply facilities be incapacitated

Additionally, federal grants and money from state and local governments fund security improvements, including security cameras, secure radios, fencing, and guard posts. Congress increases the funding for the security of federal water facilities. Thorough investigations of facilities have identified vulnerable areas for terrorism and have addressed the problems. This has reduced the vulnerability to chemical and biological weapons and explosive devices. Water is carefully monitored to detect any changes in its chemical and biological structure, and the Public Health Service works with the National Institute of Health and other agencies to reduce vulnerability to exotic diseases and chemicals that might be introduced into water systems. Defenses include new vaccines as well as mechanical means to reduce vulnerability. The borders around facilities are regularly patrolled. Levees and dams are frequently inspected for any actual or potential structural failures and are upgraded as needed. Upgrades take into account the probable results of climate change, as well as future population growth and economic development. Together, these efforts significantly reduce, but cannot eliminate, the vulnerability of water resources infrastructure to natural and man-made disasters.

Polarity U9B—Significant vulnerability of water resources infrastructure

The nation does not perceive serious natural and/or man-made threats. Consequently, few protective measures are implemented, nor are any organizational

moves made to heighten security oversight. The result is that the nation's water supply is vulnerable to chemical and biological terrorism, including the introduction into municipal water facilities of deadly biological and chemical agents. Periodically, domestic and international terrorists disrupt water services by blowing up a pipe, treatment plant, or even a dam's spillway. The nation's water infrastructure invites disaster.

Uncertainty U10—What will be the pace and effect of climate change on the U.S. environment and population by the year 2035?[2]

The greenhouse effect is profoundly affecting the earth's climate. The earth is eight to ten degrees warmer than it was thousands of years ago. Just in the twentieth century, temperature in the Northern hemisphere has increased one degree centigrade. A mixture of gases causes the Greenhouse Effect, roughly one-half of which is carbon dioxide and the rest a combination of methane, nitrous oxide, ozone, and man-made chlorofluorocarbons. Experts predict that the effect will cause global temperatures to increase, sea levels to rise and precipitation and soil moisture to change, with important effects on flooding, inland navigation, and agricultural production. Reduced rivers flows would force increased reliance on irrigation. Floods, forest fires, and droughts (for instance, in the American West because of reduced snow packs) would become more common. Crop patterns would significantly change. Warmer ocean temperatures could cause an increase in the frequency and intensity of hurricanes.

While the scientific community overwhelming accepts the data that shows rapid climate change, compared to long-term historical trends, controversy exists over exactly how rapidly it will happen, what are the consequences, and what should be done about it.

Polarity U10A—Gradual and Minimal Effect of Climate Change

The United States survives climate change, optimistic and confident despite periodic problems. Climate change is gradual, under one degree Centigrade over the next three decades. Consequently, crop, vegetation, and woodland patterns do not change much. River flows follow historic hydrologic regimen, although more frequent and intensive storms change the extremes. Drought increases in the American West as snowpack decreases and evaporation rates increase, but can be handled through conservation and manipulation of available water supplies. Decreased snow and increased rainfall in the West cause more springtime flooding in the Mississippi River basin and the Sacramento River valley. Sudden storms cause more landslides in the Los Angeles area.

Coastline loss varies considerably. The impact on productive ecosystems—coral reefs, mangrove forests, salt marshes, etc.—might be substantial. Partly due to structural barriers, the impact on most cities will not be dramatic, although coastal flooding during

[2] Note: Following discussions with USACE senior leaders, Uncertainty 10 was changed to "What will be the frequency and effect of disasters on U.S. environment and population".

hurricanes and storms will increase. Basically, the United States government thinks it can weather the weather.

Polarity U10B—Abrupt and dramatic effect of climate change

By the year 2035, the average global temperature has risen about one degree centigrade, and the polar ice caps are steadily melting. The North Pole is on its way to being seasonally ice free by the year 2050. While this has not had the drastic impact on the coastlines of the world that it will have in the period after 2050, more subtle effects are occurring. A steady decrease in habitat has led to the near extinction of various species. Salmon populations in Alaska are drastically declining as melting permafrost pours mud into rivers. Polar bears are drowning and are dwindling in number as the amount of sea ice declines. Further south, rising temperatures force animals to higher elevations. Pine beetles chew their ways through millions of acres of forests. Plant life, particularly at the extremes (Arctic tundra and tropical forests), suffers.

Glaciers in the Rocky Mountains have ceased to exist. Snowpacks are much reduced or even gone. Severe floods on the Missouri and Mississippi rivers and tributaries occur just about annually, with loss of life and property. Droughts are experienced more frequently throughout the United States. More hurricanes hit the Western part of the United States and the Northeast. Urban water supply and stormwater systems are severely stressed, with no management plans or structural answers to the extraordinary hydrologic variability that many communities experience.

There is a general recognition that climate change has gotten beyond the "tipping point" and changes must be made in response. However, budgetary strains often result in halfway measures. The National Response Plan includes mandated water management requirements during droughts and floods to conserve water. Surge barriers are being built at Arthur Kill, Verrazano Narrows, and Long Island Sound to protect New York City. Similar barriers are being built around Miami (Miami Beach is already conceded as a total loss by the end of the century), Los Angeles, New Orleans, and other major coastal cities. More severe flooding on the Mississippi forces a re-evaluation of the Mississippi River and Tributaries Project. People move from especially vulnerable areas, such as the Gulf Coast, to safer areas inland. The U.S. is worried, very worried.

Uncertainty U11—To what extent will available water of acceptable quality satisfy multiple social demands by the year 2035?

Water resources are stressed. The United States faces difficulties in ensuring sufficient water of acceptable quality to meet multiple purposes. Because of climate change, hydrologic variability increases, raising the probability of extreme events—droughts and floods. Sites for water storage are minimal, with most additional water storage coming from the use of underground reservoir sites (i.e., old mines, depleted aquifers). Water markets, conservation, new technologies, and flexible water management are necessary to increase efficient use of water and adapt quickly in times of crisis. This is a world of

distinct winners and losers, with politics making the determination as much as actual water availability.

Polarity U11A—Available water fully satisfies social demands

Competing demands for water are managed through innovative institutional accommodations that allow for water diversions and inter-basin transfers, as well as through water conservation. This management requires cooperative agreements among a variety of regional water users. Water markets increase the price of water, forcing conservation and encouraging the use of various technological devices to limit water use. Drip irrigation improves water use for agriculture and allows more water to be diverted to urban use. Social demands are satisfied, but only because some social demands have been modified, and the common fear of insufficient water forces cooperation among formerly competing political entities.

Polarity U11B—Available water is inadequate for demands

Continued political competition and conflict preclude any regional water management solutions. Instead, communities still compete for available water supplies, including groundwater Underhanded tactics are common, and occasionally illegal attempts are made to tap water going to other communities. The lack of access to water forces communities to curtail their economic development and use water rationing and water markets to limit water use. An intense market in water rights develops, with wealthy communities and industries buying water rights (in some cases to unproven sources) and denying water to poor communities and small business industries. None of this helps in times of drought. Water quality drastically declines, and in some cases there is not enough water available for basic needs. Some small communities in the arid West become ghost towns.

Uncertainty U12 To what extent are non-structural measures used to solve problems?

Polarity U12A Significant

The public prefers non-structural solutions and water conservation for flood control and water supply problems. Additional areas include river restoration and preservation of wetlands accomplished through zoning ordinances, building restrictions, and flood insurance. Non-structural measures significantly reduce social and economic impact of disasters by getting people and structures out of harm's way. Regulations at all levels of government require non-structural flood control solutions and flood insurance. Structural answers are allowed only if it can be shown that non-structural approaches are practically not possible.

Polarity U12B Minimal

The public prefers structural solutions for flood control and water supply like dams, levees, aqueducts, etc. Non-structural solutions may reduce the economic and social impact of disasters, but are not socially or politically acceptable.

Uncertainty U13 To what degree will water resource construction and management be privatized?

Polarity U13A Strong private involvement

Incentives are put in place to encourage the private sector to plan, build, and operate water infrastructure alone or in a public-private partnership. Incentives include tax breaks, revenue sharing schemes, access to low-cost funds and operating concessions, among others. Partnering is done at different levels of the government (Federal, State, and/or Local). There is also involvement of NGOs and non-profit organizations in overseeing the private activities.

Polarity U13B Weak private involvement

Construction and management of water resources infrastructure is executed exclusively by the public sector (Federal, state and/or local governments).

Appendix C Scenarios

U.S. Water Resources Scenarios

Plenty of Plenty

In the year 2035, the U.S. government had become far less intrusive in everyday life, as local and state governments assumed more of the daily decision-making affecting people's lives, and private corporations and non-profit organizations accepted responsibility for providing services and goods formerly offered by public agencies. Infrastructure investment often mixed private and public monies; so did the provision of public services, including housing, food, and medical care for the needy. The virtues of this approach were manifest. Public-private partnerships provided infrastructure in areas that otherwise would have suffered from sub-standard, even harmful, transportation, electrical, and water supply systems. They supported some important technological advances in transportation. They also ensured close cooperation during and after disasters and provided the necessary mix of funds and technical expertise to heighten infrastructure security throughout the nation. In many cases, private firms ran infrastructure facilities at the local, state, and federal levels, with government agencies setting standards and inspecting facilities to eliminate violations.

Globalization was a fact of life, and American engineering firms found it often more cost-effective to turn to foreign engineers, either hiring them directly or outsourcing work to foreign firms. Fossil fuel remained the major source of energy, and enough was available to significantly reduce investment in alternative fuels and technologies. The weather also cooperated, as the worse predictions about global warming did not come true, and much of the United States enjoyed continued good weather, infrequently interrupted by major natural disasters. Faced with few worries, the United States grew complacent. Only incremental advances in science and technology occurred.

Heightened interest in environmental values affected plans and policies for water resources development. It also led to changes in manufacturing, as many companies opted for using smaller, global, suppliers rather than concentrating production in large—and often environmentally harmful—plants. It also meant that many industries adopted the principles of industrial ecology, with a heavy emphasis on sustainable development and the reduction of waste. By 2035, too, engineers saw themselves as managers of natural systems with definite responsibilities for protecting the environment as well as providing economic development.

I. *Politics Home-Style*

Looking back, the events seemed almost a conspiracy to display the federal government at its worst. First there was 9//11, then Hurricane Katrina, the dashing of

dreams in the ruins of Iraq, and finally the breakdown in communications and logistics in the California earthquake of 2008—despite the creation of the Department of Homeland Security and various mini-security agencies at the state and local levels. What faith remained in the competence of the federal government disappeared as San Francisco dug out of its devastation.

Policy-makers joined the public in demanding a new kind of government, one which shared power with nongovernmental organizations, both private sector enterprises and nonprofit agencies. The result was a trend towards what Professor of Public Management H. Brinton Milward and others in 1991 called a "hollow state," one in which government organizations provided essential services, but the nongovernmental sector provided most of the production. Redefining the boundaries between the private sector and government took years. The focus was not on structure but on shared purpose—and problems—with public and private employees working together in various configurations according to project. In short, government hierarchical structures gave way to knowledge-driven networks of power.

Part of this network approach was the continuation of a trend that had actually begun in the 1980s, the shifting of authority and responsibility to lower levels of government, the result of a generally conservative approach that de-emphasized the role of the federal government and placed more burdens on non-federal private and public agencies. This delegated authority allowed state and local governments both to draft and implement policy to meet regional needs using in some cases federal resources. Government increasingly became viewed from the bottom up, and successful government managers were ones who could work easily across political boundaries and provide products and services in a seamless, transparent way.

By the mid-2020s, the new approach was firmly entrenched. Its virtues were clearly revealed in the aftermath of the terrorist attacks of 2030, when an internationalist group of radical eco-engineers, whose concerns focused on biodiversity issues, but who seemed equally concerned about lack of promotion opportunities and insufficient attention to basic research, attacked various infrastructure facilities—energy, transportation, and water. Private-public partnerships had made water resource and other infrastructure facilities significantly less vulnerable to attack, and, working together, the various levels of government were able to round up most of the instigators and minimize the damage to surrounding communities. Largely under the direction of state and local governments, private firms and aid organizations helped in the disaster relief and recovery operations, so that any damaged facilities were again operational within a short time.

II. *Carpe Diem*

In the year 2006, the economic outlook was ambiguous at best. The United States faced a huge federal deficit, an inadequate tax base to support infrastructure projects, and the probability that its entitlement programs would face insolvency in the decades ahead.

However, a number of developments combined to put the U.S. economy on a stable foundation for accelerating growth.

1. A new administration in 2008 obtained congressional support for increased income tax rates in exchange for the creation of a simplified income tax system free of all but a few (i.e., mortgage deduction) loopholes. The emphasis was on government efficiency.

2. New knowledge-based networks provided greater efficiency and reduced the number of government employees. The definition of "public goods" was narrowed, and government at all levels opted for the role of regulator rather than producer.

3. A vibrant international economy provided opportunities for growth, and restructured U.S. corporations, using outsourced help, produced services and products that competed well on the world market. The consequence was a greatly reduced U.S. deficit. At the same time, U.S. companies faced stiff competition from overseas firms, even on domestic construction projects. U.S. engineering firms found they could hire overseas talent, allow them to stay at home, and use their services via the Internet, all at a much cheaper cost than hiring American engineers. Public investment was high, and the Federal Reserve kept relatively benign inflation under control. Globalization was the rule, but the increased wealth was inequitably distributed. The rich became richer; the poor, poorer.

4. Government rules and self-regulation ensured transparency and limited currency volatility.

5. The U.S. continued to depend on domestic and imported fossil fuels for its energy, although hydropower and wind power also grew.

6. Demand pricing for water and toll roads instead of an aging Interstate Highway System reduced government infrastructure outlays.

The last requirement for remedying the heavy drain on the federal mandatory budget came in 2015, when Congress finally passed legislation to provide for public housing, food, and health care for the needy. The program was put under a board of officials appointed by the President and confirmed by the Senate that reported to the Department of Housing and Urban Development. Habitat for Humanity built the houses; a consortium of national grocery store chains administered the food program; and the Departments of Veteran Affairs and Defense provided health care through VA and DOD hospitals and additional community clinics. Funding came from luxury taxes on perfume, tobacco, alcohol, luxury cars, jewelry, and other designated items.

In the 2020s, the economy was in hyper-drive, with significant investment in all major sectors, a spurt of home building and commercial construction, especially in the fast-growing suburbs, and a tax structure that not only seemed equitable but bearable.

The Earth was warming but so far no major events could be directly attributed to the phenomenon, and government regulation seemingly provided sufficient guarantees against significant environmental degradation or threats to public health. So far as energy was concerned, fossil fuel remained abundant; indeed, the United States exported coal to numerous countries which had few energy sources of their own. Little incentive existed for revolutionary technological innovation in energy or many other fields.

III. *Infrastructure Partnerships*

The continued expansion of the population, particularly in the suburbs, a trend going back to the mid-twentieth century, created new requirements for water and wastewater management systems in the 2020s. Much of the burden of construction and financing fell on local governments, which turned to the private sector for assistance. Some localities reached agreements with private companies (many with international ties) to construct new facilities and operate them for a defined number of years. In exchange the companies could, under local regulation, set prices and collect revenue, much like an electric utility. Other cities joined in partnerships with the private sector in order to construct and operate water systems. A growing public willingness to pay market prices for water helped provide the means for necessary construction and maintenance. Those unable to pay market prices could have their bills reduced through an appeal to a local government agency.

Public/private partnerships had resulted in incremental technological advances in transportation by 2035. Intelligent Transportation Systems (ITS) technology improved the capacity of the highway system, while the modernization of the nation's air traffic control system and continued investment in airport capacity alleviated problems in aviation. By 2030, travelers on the nation's highways had real-time access to information of all types, including transportation availability, geographic location, and operating conditions over selected trip segments. High speed passenger train service (the "Acela") existed on most parts of the nation's railroad system. High-speed ferries were used in several cities to alleviate bridge and road traffic. They provided cross-river and bay transportation as well as connections to selected terminuses along the water bodies. Freight transportation grew by 5 billion ton-miles by 2025, with a high volume of smaller shipments to satisfy low production and distribution requirements. Highly integrated freight transportation companies provided full service, employing multiple transportation modes and services. Domestic waterborne freight increased only moderately, but international freight movement significantly increased, requiring larger ships, deeper channels, and high-capacity, highly efficient intermodal cargo ports. Air cargo, utilizing both larger freight aircraft and passenger aircraft, increased, but trucks continued to dominate the freight transportation market.

At the beginning of the 21st century, the federal government faced major challenges in its inland waterways system. Nearly half of the 257 USACE-constructed locks on more than 12,000 miles of waterways were functionally obsolete. Yet, the operations and maintenance budget had remained relatively unchanged in constant dollars, inevitably postponing critical maintenance. Recognizing the importance of

waterways modernization, Congress appropriated additional funds for modernization of critical locks and dams in the second decade of the century. Meanwhile, the Inland Waterways Users Board drew down the Trust Fund as it agreed to fund work on other inland waterway projects. The result was that the waterways system continued to support the nation's needs adequately. Continued dependence on fossil fuels resulted in increased transport of Appalachian coal, with its lower sulfur content (hence improving air quality) and close proximity to eastern markets, which reduced energy costs. The transport of limestone, soybeans, and corn also increased, particularly when the United States began to export corn to China, where it was used for ethanol production. Surface transportation reached saturation levels, so waterways remained a kind of safety valve, which would be severely tested in the event of military conflict or a major national disaster.

Flood control remained a concern at the beginning of this period, particularly after Hurricane Katrina. Yet, as several years passed without any similar catastrophe, Congress lost interest in massive aid for flood control. While most flood control facilities were well-maintained, approximately $45 billion worth of critical maintenance requirements remained unfunded. The situation changed after 2015, when modifications in entitlement programs allowed more money to be shifted to discretionary needs. Over the next 15 years, the federal government either directly oversaw the modernization or replacement of critical flood control features or provided funds to non-federal interests to do the work. As localities and state agencies showed increasing capability to manage navigation, hydropower, and flood control facilities, and the willingness to operate the facilities themselves, a number of federal facilities were turned over to non-federal control, although federal standards provided the minimum operating guidelines.

In the 2020s, governments at all levels improved the water infrastructure. Underground reservoirs were created to store water. Desalinization plants along the West Coast supplemented traditional water supplies during drought or heavy use. Irrigation channels were lined to prevent water loss. Pipelines transported water from Canada, making full use of NAFTA legislation. That same legislation provided for Quebec hydropower to be sold in New England at competitive rates. Ports were modernized to meet the requirements of modern containerships and bulk cargo carriers. The use of new information technology allowed handlers and distributors to mark where and when a container should be loaded and when it should arrive at its destination, eliminating expensive storage needs.

Other infrastructure services, such as roads, bridges, and airports, also benefited from the increasingly robust discretionary budget, although toll roads and bridges built by private investors became more common and airlines continuously raised fares to cover necessary improvements in airport security and services. The federal government's contribution to actual construction and even maintenance declined as non-federal and private interests assumed more of these responsibilities. Instead, the federal government assumed the role of standard-setter—including mandated standards for reducing vulnerability to natural or human disaster—grant provider, and "court of last resort" should critical non-federal interests fail to remedy critical infrastructure requirements. In

short, the federal government played an administrative, funding, and coordinating role and left many policy issues and actual implementation to states and localities. Successful infrastructure development depended on finding partners who could provide funding, technical assistance, or whatever else was needed to achieve success.

Most non-federal interests agreed to heighten security. Here, too, Congress helped by increasing funding for grants to non-federal interests and for greater security for federal projects. Special care was taken to reduce the vulnerability to chemical and biological weapons and to explosive devises. Using federal standards, states and communities carefully monitored water to detect any chemical or biological changes. More frequent inspections of infrastructure facilities occurred. Upgrades took into account possible impacts of global warming as well as probable population growth and economic development.

IV. *Working with Nature*

After 2025, the public and governments at all levels began to integrate environmental values in policies and plans. Concerns about biodiversity, global warming, and the preservation of natural areas for human recreational use and spiritual refreshment generated much of the new attention to environmental issues. Declining biodiversity became an especially big concern. By 2025, ecosystem models projected unacceptable losses of biodiversity within ten to fifteen years. Nearly all freshwater mussels would be gone, there would not be enough crayfish to harvest, and the number of freshwater fish would decline by about 40 percent from the year 2000 estimates. More than 200 salmon and steelhead stocks were in danger of extinction. Also while global warming was not considered a major impediment to economic development, it had become clear that changing weather patterns had brought various invasive insect species into areas where they threatened both agriculture and forestry. Many of the threats to biodiversity resulted from the enormous decline of riparian habitat resulting from irrigation and navigation development and urban expansion. Declining biodiversity received additional attention in 2030, after the eco-engineers attempted to destroy various infrastructure facilities. In sum, the public perceived the necessity for balancing economic development with environmental protection.

While some of the most pessimistic forecasts concerning global warming did not prove accurate, people could not help but note some unsettling developments. The ocean level rose very gradually, annual temperatures increased moderately, winter snow storms declined, the growing season for wheat and other grains lasted longer and extended further northward, and crop patterns changed. In some parts of the country river flows decreased and forced greater dependence on irrigation. Constraints on private land use helped reduce the rate of loss of wetlands, and water was generally abundant. Where water was not sufficient for municipal and industrial use, communities usually reached water-sharing agreements by which the receiving communities agreed to build infrastructure to transport and store water sold to it from a neighboring water utility. State and federal agencies mandated minimum in-stream flows. In any case, throughout the country water needs were generally met.

The mix of globalization and environmental values created significant economic change by 2035. Large scale manufacturing plants dwindled as many companies found it both economically and environmentally advantageous to distribute work to numerous smaller plants around the world. These smaller plants were turn-key operations; they might work for one global company one year and for another one another year. A high level of compliance to environmental standards was one of the services these smaller plants provided. Meanwhile, engineers developed an Earth Systems Engineering and Management (ESEM) capacity (Allenby 2005a). Here the goal was to facilitate the active management of natural systems. Rather than trying to engineer natural systems in the traditional sense of control, engineers assumed responsibility for perturbations resulting from technological or industrial initiatives (Allenby 2005b). The approach implied a new definition of engineering responsibility and demanded improved technologies—available by 2035 despite general lack of technological innovation—for long-range forecasting of ecological systems. It also assumed that some ecosystems (i.e. Florida Everglades) could never be returned to a pristine condition and therefore will require constant monitoring to minimize human impacts as much as possible.

In many ways ESEM complimented the increased emphasis on industrial ecology, the design of industrial systems to resemble more closely natural biological systems. It attempted, as well, to understand better the interactions within and between industrial and ecological systems. Most obviously, it required a holistic, interdisciplinary, systems approach. However, this approach was not linear, but cyclical, whereby wastes are reused as energy or raw materials for further production. No waste would leave the industrial system or negatively affect natural systems. In the end, the goal was sustainable development at the global, regional, and local levels. By 2035, this approach was commonplace among most industries in the United States.

The interest in ESEM did not doom structural approaches, but meant that infrastructure facilities were constructed in a manner meant to minimize environmental impacts. Conservation measures that required more efficient toilets, water taps, and water facilities also reduced the need for additional infrastructure. Water was available, although market pricing resulted in increased cost. Those who clearly could not afford to pay the increased cost were provided with government subsidies. Overall, life was good.

Cracking Up (renamed Global Malaise)

In 2035, America's infrastructure was a metaphorical mix of glue and sticks, kept together in more or less ad hoc ways, as governments scurried for funding, and private firms, worried about the economic climate, refused to offer much assistance. State and local governments tried to locate funds to compensate for declining contributions from the federal government, as Congress provided just enough funds for absolutely critical repairs, and left other infrastructure work to non-federal governments and the tax revenue obtained from the Inland Waterways Trust Fund, itself now stretched to cover federal infrastructure expenses other than waterways. Fortunately, generally benign weather patterns did not bring on the prolonged drought or flood conditions that everyone feared, and water supplies met social demands. The one important exception was that lack of funds occasionally prevented the infrastructure from being extended to outlying areas or to poor communities.

Problems with China had led to economic recession in this country and an increasingly protectionist attitude. The isolationist response gradually spread to other countries, as many multi-trade agreements were not renewed in the second decade of the 21st century. Americans became increasingly inward-directed. They continued to depend on fossil fuels, including coal, which became even more important as protectionist policies and disagreements within OPEC contributed to unreliable oil supplies from the Middle East and Venezuela. The inability to solve the burden of growing payments for entitlement programs and interest contributed to domestic fiscal crisis. In 2035, the economic climate embraced an approach to infrastructure problems that emphasized the essential and placed little importance on environmental protection or sustainable development. Similarly, lack of funding, including private investment, resulted in little innovation, and the collective approach to infrastructures was to stick a communal thumb in the dike. The consequences of this approach clearly emerged in 2028, when New York City suffered from the onslaught of a category 5 hurricane. Surge barriers for the city had been repeatedly discussed but never built, and in 2035 the city still had only partially recovered. Following this disaster, many people left coastal communities and permanently moved to the country's interior. The nation appeared on autopilot, just managing to keep going.

I. *So Much Water, So Little Time*

The United States faced an overwhelming number of demands for modernization of its infrastructure in the early 21st century. Roads, airports, and railroad track needed repair. Many locks and dams need to be rehabilitated or replaced. Small communities required improved drinking water facilities, wastewater management plants, and storm sewers. However, increasing population, fed partly by emigration and partly by high birth rates, strained the ability of local and state governments to provide infrastructure and also essential social services, including schools. The federal government exacerbated the problem by underfunding federal programs and leaving it to non-federal interests to make up the difference. Private firms, beset by concerns about inflation and a weakening

dollar during a time of increasing protectionism, declined to help. States and localities allocated available infrastructure dollars for the construction of drinking water systems and sewage and stormwater facilities.

While infrastructure decayed, the amount of water available was adequate to meet most social demands. This circumstance partially resulted from good luck, especially generally benign weather patterns. Some weather-induced disasters struck, but not at a much greater rate than had been the case in the 1990s. Still, without an adequate infrastructure, major and inequitable misallocations of water occurred. Poor people suffered from unreliable water systems that often promoted disease. Groundwater pumping and septic tanks dramatically increased in the outer suburbs as communities refused to extend their infrastructure to new housing developments. Water became an issue that often surfaced in local political and statewide contests.

II. *Homo Plodder*

Americans lived on credit, and America survived on debt. When one foreign loan became due, the United States would borrow from others. In 2001-2003, the nation added more debt than had been built up in the first 200 years of its existence. And the debt continued to grow for the rest of the decade, as war, entitlement programs, and misguided attempts to cut taxes ate into the federal budget. The whole financial structure depended on continued foreign (and domestic) belief in the strength of the dollar.

That belief halted in 2009. By that time a recession had hit the country during a market "correction" that ended up stopping capital spending and convincing millions of investors to leave the market. Consumers decreased their spending and increased their savings. Private firms declined to invest in research and development or capital expansion. Jobs declined. So did trade, as American stopped buying so much from China, Japan, and other countries. This helped the balance of trade, but it created some international friction. Meanwhile, the American government continued to support military actions in several countries in attempts to promote stability and democracy. Increasingly, both foreign governments and many American citizens concluded that these activities rarely achieved their objectives, but they certainly did increase the U.S. debt.

Chagrined by the declining American investment in China and declining sales to the United States, Chinese banks conspired to lower the value of the dollar. They began selling their enormous holding of dollars. Their action immediately caused a run on the dollar that was stopped only when the U.S. government declared a two-day bank holiday. The Chinese action led to increasing protectionism and isolationism on the part of the United States. The U.S. government began withdrawing from various trade treaties. Other countries did likewise.

Meanwhile, the U.S. financial system could not overcome the political and economic inability to address federal spending on retirement and health services. The imbalance between tax revenues and federal spending escalated, so that by 2035 payment for interest and entitlement programs constituted more than 15 percent of the nation's GDP and substantially more than half of the federal budget. Mixed with trade

imbalances, protectionism, and decreasing domestic and foreign investment in the United States, the nation faced a grim future.

III. *Political and Social Babel*

Insufficient funding and decaying infrastructure contributed to fractured politics. The problem extended to the preparation and response to major disasters. Localities were reluctant to take on responsibilities if they did not receive more federal funding. The federal government refused to assume responsibilities without obtaining more flexibility to impose solutions on regions and localities. With few major disasters occurring, people fell into complacency. Public works officials did not always educate their successors about the importance of disaster preparation and recovery. Old plans were not updated, and Congress began to cut back funding to the federal emergency relief agencies. By 2020, the situation at local, state, and federal levels was not unlike that which characterized the period just before Hurricane Katrina.

The water resources infrastructure remained vulnerable to both human and natural disasters. Few politicians displayed any enthusiasm for spending money on infrastructure, including rehabilitation and operation and maintenance, unless the structures clearly threatened health and safety and were economically critical. The federal government appropriated enough funds only to inspect dams and locks, dredge important navigation channels, and to pay the federal share for the rehabilitation of significantly deteriorated key locks, dams, and levees. It also increased the inland waterways fuel tax. Concurrently, in 2015 Congress amended WRDA-86 to open up the waterways trust fund for flood damage reduction projects as well as for inland navigation, based partially on the conclusion that historically "flood control" and navigation projects were often linked. More than that, the political attractiveness of "stealing money from Peter to pay Paul" could hardly be ignored. In reality, this "program" continued to delay major decisions until the proverbial rainy day.

Ominous predictions about global warming brought forth heated discussion and carefully detailed plans for modernizing flood control structures, but, as the years passed without major disasters and governments at all levels found their budgets squeezed, little construction occurred. The most ambitious plans would have put giant surge barriers at Arthur Kill, Verazanno Narrows, and Long Island Sound to protect New York City against storm surges. Similar barriers were planned for Miami, Los Angeles, New Orleans, and other coastal cities. In the end, though, carefully drawn blueprints did not lead to completed projects.

Consequently, in 2028, when a violent hurricane drove up the East Coast of the United States, feeding on the warm waters of the Gulf Stream (which had increased in temperature over the previous thirty years), one could do little except evacuate cities and protect whatever one could. The hurricane actually became more powerful as it headed north, so that by the time it hit New York City it was a category five giant. The storm sent a powerful surge against Manhattan Island that ripped through much of the West side, inundating the area where the Freedom Tower (site of the old World Trade Center

towers) sat, inundating the New York Stock Exchange, and bringing to a standstill all transportation facilities. Hudson River terminals were destroyed, and one part of Brooklyn Bridge appeared ready to fall into the East River. The Statue of Liberty looked ready to fall over. The New York Stock Exchange closed for a week, greatly disturbing world markets, and temporarily moved to Philadelphia; other firms relocated in various parts of the country, some temporarily and some permanently. New York City lost billions of dollars in destroyed infrastructure and drastically reduced revenue. Maritime companies had to shift their operations to other ports. The country's GDP dropped fifteen percent that year. The federal government did what it could to help the strapped metropolis, but in 2035 the city had still only partly recovered.

The New York City disaster resulted in both population and economic dislocation over the next decade. Many New York City residents who lived in lower Manhattan never returned. Residents of other coastal cities, some of which had also suffered severe hurricane damage, also decided to leave permanently for the country's interior, thus reversing an internal immigration pattern of moving to the coast that had lasted for a century or more. The majority of those who moved were professionals, who could afford the expense. Indeed, many of them were water enthusiasts, who brought their ocean-going boats and yachts to inland lakes on the Missouri and Colorado rivers, thus requiring new marinas and recreational services. Left behind were retirees living on fixed incomes, poor people unable to move, and many minority groups (some with U.S. citizenship and some without), who not only did not have the financial means to move but who were uncomfortable moving to an overwhelmingly white, Protestant, "bread basket America." The consequence of this demographic shift placed an enormous financial burden on coastal cities and posed social challenges that tested government capability at all levels.

IV. *A Patch-Work Nation*

The post-2010 world mirrored the world of the past, at least in terms of science and technology. Insufficient investment capital, lack of governmental leadership, and public apathy sharply limited research and development in energy and water resources. Generally, adequate water existed, so that little pressure existed to develop water conservation measures. The problems were, first, to allocate the water in a politically acceptable manner and, second, to identify funds to build the infrastructure. . Rapidly growing suburbs (except in coastal cities after 2028) demanded infrastructure development, which often occurred with little regard for environmental impacts. Indeed, new federal legislation allowed federal agencies to waive requirements for environmental impact statements if the postponement or elimination of the proposed project would create severe economic hardship. Numerous states followed the federal lead and amended state environmental impact requirements. More or less indiscriminate housing development threatened wetlands, reduced instream flows, and imperiled water quality. Some communities could not afford modern infrastructure, and minority populations especially suffered adverse environmental consequences, such as polluted water and air. For these populations, public health issues increased. Once pollution was evident, localities that had the necessary funds would seek ad hoc technological solutions, aimed

to solve specific problems. They ignored more generic social and political questions and rarely approached surrounding communities to develop a watershed approach to the problems. Private sector companies invested only in projects that promised returns to shareholders, and environmental solutions usually were neither so profitable nor so likely to provide quick returns as structural solutions.

The prevailing patchwork infrastructure in the United States inspired little interest in innovative environmental solutions. The attitude was to stick a collective thumb in the dike until better times allowed for more infrastructure investment and construction. Flood control issues inevitably led to structural solutions that severed ecosystems, reduced water quality, and threatened fish and wildlife. Federal agencies interpreted national economic development in terms favorable to local elites, with little regard for issues of environmental justice or intangible costs. Land and water resources deteriorated.

The nation continued to rely on fossil fuels, which contributed to regional air pollution and global warming. Transportation needs gobbled up tremendous amounts of petroleum, while electrical generation relied on America's ability to mine ever greater amounts of coal:

Thus, rooted in the past, distressed in the present, the nation managed—but just managed—to roll along.

New Order

In 2035, hydrogen stations dotted the automotive landscape. Scattered here and there were also ethanol stations, which dispensed a fuel of 85% ethanol and 15% gas. Missing almost entirely were the gas stations that once dominated city streets and highways. Hydrogen produced through electrolysis provided energy for both vehicles and home. However, electrolysis itself uses energy, and its successful development depended on technological innovations that enabled greater use of non-carbon energy sources, such as hydropower, photovoltaic, wind, and geothermal resources. Innovative technology was not confined to energy. Genetically modified organisms drastically increased crop yields, although poorly monitored programs resulted in economic and social dislocation. Still, technology and science revolutionized American life, reduced dependence on fossil fuels significantly, and consequently reduced carbon emissions that had contributed to global warming.

Revolution of sorts also affected the federal government. Through the implementation of a host of new rules and hiring guidelines in the first decade of the 21st century, the federal government slowly attracted employees who were capable and ambitious and knew how to work closely with their counterparts in state and local governments and in the private sector. By 2035, mid-level federal bureaucrats set and enforced standards and oversaw program and project budgets, but their non-federal colleagues assumed more authority for policy development and implementation. Non-federal governments applied for infrastructure funds from a central National Infrastructure Financing Agency (NIFA), rather than lobbying specific agencies or depending on infrastructure trust funds, which had been abolished. Close coordination also paid off in the effective way governments worked together in response to disaster.

Changing weather patterns tested water managers, but here too close coordination proved indispensable. The strong environmental values that had come to dominate water planning resulted in intensive Integrated Watershed Management to manage entire watersheds, not just specific cities or agricultural areas. These values—supported by various laws and regulations—in concert with new technological innovations, allowed water planners to develop projects in accordance with the principles of sustainable development, balancing economic and environmental requirements. In some cases, the federal government took the lead in offering technical assistance and suggesting how to develop water infrastructure within the framework of comprehensive watershed management. Finally, the federal government provided funding and technical assistance to reduce the vulnerability of non-federal and private sector infrastructure projects.

I. *Homo Faber*

Ubiquitous hydrogen, found on earth and water and carbon-free, promised a new source of energy that will never run out. The hydrogen in water and organic forms comprises 70 percent of the Earth's surface. However, it is rarely free-floating. It needs

to be extracted from natural sources. In the period 2006-2035, a general embrace of environmental values, significant technological innovations and justified fears of decreased availability of oil and gas because of slowly dwindling supplies and population growth led to a "hydrogen economy" well before skeptics thought it possible.

In the 1990s, engineers and scientists had already begun to develop hydrogen fuel cells that were used in some commercial buildings and homes. These fuel cells separated incoming hydrogen gas into protons and electrons. When the protons and electrons meet at the cathode, they join with oxygen to form water and heat, which are released as exhaust. A single fuel cell could produce just over one volt, so hundreds are stacked together for most applications. Major automakers spent more than $2 billion to develop hydrogen fuel cells for cars, buses, and trucks. Efforts accelerated in the first decade of the 21st century, as high gasoline and oil prices, combined with the public embrace of environmental values, resulted in a growing research and development budget for alternative fuels. Congressional enactment in 2010 of a grant program to stimulate research greatly accelerated efforts; the Department of Energy administered the program.

Developers and entrepreneurs faced several problems. First, fuel cells were expensive. Second, most hydrogen was produced from natural gas, which emits carbon dioxide in the conversion process, thus contributing to global warming. Third, a hydrogen pipeline or other distribution system (trucks and rails) was expensive, and, fourth, the whole process entailed major safety issues.

The answer to the first problem resided not so much in technology as in marketing. Rather than obtaining energy from large public utilities that built huge energy plants and transmission lines, purchasers using fuel cells could have their own miniature power plant right in their own building or home with an inexhaustible supply of energy. If manufacturers could convince people to make the initial investment, the law of supply and demand would take over, and the unit price would decrease. These fuel cells would prove infinitely more reliable than depending on standard electrical grids (many of which depended on fossil fuels). They promised to become popular with elderly people, who needed reliable energy to power life-sustaining medical equipment, and with those responsible for ensuring security against terrorism or natural disaster; it was far easier to protect an on-site power plant than to depend on transmission lines and power plants many miles away. Engineers developed small production facilities using wind or solar power that were capable of being used in the home, office, or factory,

The answer to the second problem took longer. The production of hydrogen using natural gas had never been all that popular since the process resulted in contributing to global warming. However, natural gas production peaked in 2020, and other ways of producing hydrogen had to be found. Photo-voltaic, wind, hydro, geothermal, nuclear, and other forms of renewable energy held out the promise of efficiently providing enough energy for the electrolysis process to split water into hydrogen and oxygen without emitting carbon dioxide, but development costs were expensive. By the end of the decade significant technological breakthroughs had occurred, however, including advancements in solid-state hydrogen storage, which lowered costs, and the public came

to accept the idea of paying more up-front for something that would provide energy into the indefinite future.

Even in a generally thriving economy, many obstacles confronted the creation of a whole new hydrogen pipeline distribution system for vehicles. Instead, local production was preferred, where hydrogen fueling stations, employing electrolysis, produced hydrogen on-site. However, this technology did not eliminate the need for very large fuel tanks, which had to sustain 5,000 psi of pressure and be considerably larger than gasoline fuel tanks. An explosion of one of these tanks—and hydrogen is highly ignitable—would be disastrous. While some of the safety problems had been overcome, the most promising approach seemed to be the development of on-board production capability, in which vehicles make their own hydrogen from stored hydrocarbons. At the beginning of the 21st century, researchers were already experimenting with producing hydrogen from methanol or combining ordinary water with reagents like boron or aluminum to produce hydrogen, oxygen, and a metal oxide residue. This technology advanced slowly, but by 2035 the transportation industry seemed on the cusp of a major revolution, with on-board production eliminating the need for both ethanol/gasoline and hydrogen fuel stations. The waterways industry likewise experimented with hydrogen fuel cells on barges and tows. Although clearly the hydrogen economy era was only beginning, by 2035 no one seriously considered returning to dependence on fossil fuels.

The development of the "hydrogen economy" inspired other technological developments. For instance, it stimulated much research into the use of biomass—agricultural and industrial waste—for energy. The gasification of biomass, developers soon discovered, could significantly reduce the cost of energy production. A generation of new and advanced turbines powered by biomass gasification reduced the cost of electricity to just two cents per kilowatt hour. Biomass electrical production became particularly popular in the Third World but no so much in the West because it produced carbon dioxide in the process.

By 2035, few cars ran on gasoline. Hydrogen fueled cars dominated. They were still a bit expensive, but most people who could afford them bought them. Also, hydrogen webs had been established, based somewhat on the Internet. Users were connected to one another, so that they could share electricity (it didn't cost any more!). Energy companies fought rearguard actions, but their time had passed. The last public utility company declared bankruptcy in 2035.

The energy revolution embraced more than the commercial development of hydrogen fuel cells. Government funding also helped to develop the ethanol industry. The use of grains and sugar cane to produce ethanol had limited production since not enough of these crops could be grown to meet domestic and foreign consumption as well as energy needs. However, the forest by-products industry provided an answer. Through the use of fermentation and thermochemical technologies, existing pulp and wood products mills could be converted into biorefineries. Small rural mills could within a short time be converted into ethanol producers that could provide energy for the

community and sell the remaining ethanol in commercial markets. Meanwhile, some new nuclear energy plants appeared. New technology considerably heightened security and safety features. A far more difficult problem was the nuclear waste. The issue was one of risk. While the technology existed to create a nuclear waste dump that hypothetically would keep the material safely secured for 10,000 years, no one could reasonably guarantee that an accident could not happen. Given that situation, few states or communities could be persuaded to accept a nuclear waste site

Other technologies also advanced significantly during the first 35 years of the 21st century. One of them was genetically modified organisms (GMOs). Genetic modification involved genetic engineering, or gene-splicing, to splice together DNA fragments from more than one organism. These fragments could then be injected into another organism. In the early 21st century, genetically modified foods produced controversy because of (1) religious reasons, (2) concerns over patent and property protection, (3) unforeseen global side effects as a result of proliferation of the modified organisms, and (4) ethical issues dealing with the manipulation of life. Those who supported genetic modification pointed to the possibilities to develop crops resistant to herbicides and insects or resistant to drought, cold, or heat. Such crops could significantly improve the economies and quality of life of some countries. In the United States at the beginning of the century, the use of genetically modified grains that resisted herbicides and insects was already common and helped boost crops production significantly.

The use of GMOs increased in the second decade of the century, as concerns about "out-crossing" or cross pollination diminished. The fear had been that pollen could be dispersed over large areas and be introduced into species unintentionally with unknowable consequences. GMO proponents noted that each genetically modified crop was carefully assessed to identify any risk with out-crossing with wild plant populations. If such out-crossing did occur by accident, little risk of significant consequence resulted. Still, the contamination of U.S. corn with StarLink corn, engineered to be insect resistant but approved only for animal feed, happened in 2000 and resulted in a dramatic drop of corn exports. Then in 2006, U.S. commercial supplies of rice were inadvertently tainted with a genetically engineered rice variety not intended for human consumption. Again, the main consequence was a drop in rice exports from the United States. In the following years, more advances were made. By 2020, scientists had developed a strain of corn resistant to drought. The appeal was undeniable to mid-Western farmers who had endured a pattern of drought that was then in its fifth year. Some farmers were on their last legs, and thought the new GMO their one hope.

Shortly after the genetically modified corn reached the market, alarms began. People were having enormous allergic reactions. Skin blisters, rashes, and swelling occurred. Many people were hospitalized. The elderly died. It was a disaster that sent the mid-West farm belt reeling. Farmers who thought they had found the answer to their problems found themselves instead with corn they could not use and facing thousands of lawsuits. Most gave up their farms. Some gave up their lives, as suicides increased tenfold in the region.

Technology and science produced a new order, but, as always, the results were double-edged. The unforeseen and improbable produced cornucopia for some and hell for others.

II. *Tops Down*

The federal government had been everybody's favorite whipping boy in the last quarter of the 20th century, and the majority of Americans expressed distrust and lack of faith in the bureaucracy. Various reforms, however, occurred in the first decade of the new century. These not only provided more incentives and rewards for truly top performers but allowed the quick weeding out of the under-achievers an plain lazy. Promotions could come quickly to those who deserved them. The result was that more sophisticated and capable people were attracted to mid- and lower-level positions, knowing that good performance on their part could earn rapid advancement. The promise of time-off and government financial support for continuing their education especially appealed to these ambitious new government employees.

Performance was not measured in terms of just expertise or the completion of products and programs but increasingly was linked to an employee's ability to work with others in the private and public sectors. Especially important in this regard was the ability of mid-level managers to work with their opposite number in state and local offices, whether they be engineers, natural scientists, economists or in some other discipline. They were expected to work closely even with professionals in non-governmental organizations, including many advocacy groups. The idea was that good government depended on public and private professionals at all levels. These same bureaucrats also dealt with counterparts overseas when necessary and did not involve significant matters of policy.

With its new bureaucrats, capable and motivated, the federal government supplied impressive leadership. The enforcement of many regulatory programs shifted to states and localities, but competent, highly-respected mid-level managers helped set standards. They also oversaw the spending of billions of dollars for infrastructure projects, working closely with their non-federal counterparts. Finally, senior executives, formerly focused on operational aspects of their responsibilities, paid far more attention to long-range strategic issues.

All these changes garnered for the federal bureaucracy increased respect from Congress, the private sector, and non-federal governments. By 2014, no longer did one hear cries for the abolishment or reduction of the bureaucracy. Instead, federal employees were held up as the standard for good public servants and highly competent professionals.

One result of this new respect paid to federal bureaucrats was close coordination on disaster matters. Indeed, this coordination had evolved over a long time, at least dating back to the Stafford Act of 1988. In the aftermath of Hurricane Katrina, efforts

accelerated. Yet, only in the period past 2010 did the coordination become truly harmonious. The close link between state and national agencies, where everyone now their opposite number by name as well as position and worked closely with each other by phone as well as together on-site meant that everyone know what had to be done by whom during disasters. Perhaps of more importance, agencies at all levels worked on detailed plans to avoid disaster through a combination of structural and non-structural solutions, including significant attention to environmental issues and adequate forecasting and evacuation procedures. Changing weather patterns tested this new multi-level, inter-governmental response on several occasions, and the result showed that coordination and planning—with sufficient funding—really did work.

Changing weather patterns also tested water managers. Drought in the East and Midwest meant that water was inadequate to meet social demands. Only the combination of technological advances (i.e., underground water storage) and strong conservation measures prevented disaster in some areas. Here again, federal water managers worked closely with their state, agricultural, and local counterparts. A strong environmental movement had led to the creation of watershed programs throughout the United States, and federal water agencies worked closely with the administrators of these programs in order to contain floods or to provide water during drought. The National Response Plan included mandated water management requirements during droughts and floods to conserve water. By 2030, the federal government required that each watershed administration enforce federal standards, and occasionally a federal inspector checked to see that no violations happened. The federal government paid the bulk of the costs for major projects that affected water flows across state lines, but the watershed administrations were expected to provide funds (obtained from participatory states) as well. In all cases, careful attention was paid to maintaining in-stream flows and reducing any project or operation that may adversely affect biological diversity.

Finally, the increased respect for the federal bureaucracy helped lead to a major transformation in funding and developing infrastructure. In the early years of the 21st century, questions emerged about the appropriate public investment in infrastructure. Too many times, it seemed, politicians and federal agencies focused on the condition of the infrastructure rather than on desired objectives and outcomes. Could new approaches consider alternatives that might emphasize the management of demand rather than the development or modernization of infrastructure? Could new approaches establish a clearer idea of national infrastructure priorities?

In 2013, Congress took an important first step in modifying the approach to infrastructure planning. It legislatively established that environmental quality must be considered equally with national economic policy in planning projects. Four years later, in 2017, it formally amended the 1936 Flood Control Act to remove the requirement that benefits exceed costs in flood control projects. The 2017 act also required landowners in flood-prone areas to have flood insurance as a condition for occupancy, but limits were placed on insurance premiums and on the value of the policies depending on a structure's market value. Yet, one of the obstacles to genuine reform in infrastructure development remained. This was the various infrastructure trust funds—Inland Waterways, Highway,

and Airport and Airway. These funds provided funding streams but no real financial discipline nor sense of national priorities. For years, various constituencies fought to retain the trust funds, but in 2032, Congress and the Executive Branch decided on a major departure from the old ways of doing business.

All infrastructure trust funds were abolished and assets were transferred to a new National Infrastructure Financing Agency (NIFA) to provide federal assistance to roads, airports, drinking water and wastewater facilities, ports and harbors, flood damage reduction, school buildings, and other types of projects. On a case by case examination, recreation facilities could also be included. Fees authorized by Congress were still collected, and Congress appropriated funds each year for the agency based on careful NIFA analyses. Most projects would be cost-shared, with the federal share proportional to the actual federal benefit. States, regions, and localities applied for financing or grants for specific projects. One of the principal aims of NIFA was to promote overall efficiency. Its staff included a corps of professional, well-respected project evaluators. They carefully examined each application, ascertaining the cost of delay, expanded economic opportunities, social benefits and costs, environmental benefits and costs, and so forth. In short, they applied a consistent, national policy that carefully addressed all potential consequences of a project, carefully balancing economic and environmental issues. Naturally, federal agencies changed in response to this new approach, generally retaining just enough planning and analysis functions to support disaster relief and recovery, technical assistance, forecasting, and inspection programs, but continuing with the responsibility for construction and operation and maintenance.

III. *Fickle Mother Nature*

By the year 2035, the average global temperature had risen about one degree centigrade, and the polar ice caps were steadily melting. At present rates, the North Pole would be seasonally free of ice by 2050. The sea level had risen an average 10 centimeters. Changing climatic conditions had led to the near extinction of various species. Salmon populations in Alaska had drastically declined as melting permafrost poured mud into the rivers. Polar bears drowned and dwindled in number as sea ice disappeared. Further south, rising temperatures forced animals to higher elevations. Pine beetles chewed their way through thousands of acres of forest. Further south in the United States, manzanita bushes died, and prickly pear cacti became sickly pink.

Glaciers in the Rocky Mountains ceased to exist. Snowpacks melted very fast, leading to severe floods on the Mississippi and Missouri rivers and their tributaries. In 2018 (in what was otherwise a year of drought), floods took 200 lives in the Kansas City area. Droughts occurred more frequently and were more widespread than ever before in the United States, stressing urban water supplies. Yet, severe periodic flooding on the Mississippi caused a re-evaluation of the Mississippi River and Tributaries Project (MR&T). In 2022, government engineers suggested that Morgan City, Louisiana, be abandoned. The probability that the city would not survive flooding on the Atchafalaya River, a main distributary of the Mississippi River, had increased to unacceptable levels. Meanwhile, Missouri River floods caused another re-evaluation of the Missouri River

Regulation Manual. In 2020, a flood nearly tore apart Oahe Dam. Had the dam failed, the state capital at Pierre would have been devastated and much of the southern half of South Dakota would have been under water. A disaster was avoided, but at the cost of substantial upstream flooding that threatened the habitat of threatened and endangered species. Subsequently, the crest of the dam was raised and flood storage capacity increased, but it no longer seemed possible to eliminate the threats to fish and wildlife without once more readjusting reservoir levels and in-stream flows. The new rules published in 2024 required constraints on recreation and fishing and caused an uproar in the Upper Missouri watershed states.

Global warming became more intense in the period 2030-35, with the sea level rising 2.5 centimeters in those years alone. Fortunately, a multi-governmental disaster team had advocated in 2025 the development of federal/non-federal cost-shared surge barriers and other coastal protection measures including dikes and flood gates. By 2035, many of those measures were in place. At the same time, close attention was paid to the engineering of ecosystems to provide ecosystem services that would enhance coastal protection. Some relatively unpopulated coastline areas were left unprotected. Government officials had concluded that it would be more cost-effective in those areas to address storm damage after it arose than to resort to engineering structures and configured ecosystems to mitigate storm damage.

IV. *Sustainability*

New technology, conservation practice, and widely-held environmental values combined to support sustainable development in the United States. Part of the reason for the embrace of environmental values was the spread of the no-growth movement in suburban America and growing concerns about water availability and land conservation. The sacrifice of rich farmland and forests to strip malls, row houses, and industry raised outcries, particularly when relatively modest houses attracted minorities who did not share the culture of the dominant population. In these cases, environmental choice actually masked cultural and economic discrimination. To reduce water requirements and preserve woodland, many county and municipal boards imposed zoning requirements that favored large 5-acre lots for houses and imposed major infrastructure demands on developers. Wetland mitigation banks were required for any construction project exceeding ten acres in size. Other communities took another approach, restricting any development of certain parcels of land and insisting that developers provide infrastructure to support a relatively high level of population density in lands designated for residential use. States required industries to join a carbon emissions trading system similar to the wetland mitigation banks. Carbon emission rights could be brought and sold, with a maximum cap on total emission for a region.

As concern grew for preserving quality of life and the nation’s resources, all levels of government invested in environmentally sensitive tracts of land and developed tax incentives to offset investment in environmentally friendly projects. Infrastructure satisfied social demands partly because social demands for infrastructure had declined. In most parts of the country, the public favored non-structural solutions over the

construction of large flood control structures. In selected cases, Congress authorized federal agencies to move small communities to higher ground rather than spending money on expensive flood damage reduction measures. Many municipalities required the use of water-saving devices in homes and imposed severe penalties on those who did not install them. In arid regions of the country, cities and states passed legislation that provided tax incentives for taxpayers who reduced their annual per resident water use, and they penalized those whose water level exceeded acceptable standards. The federal government provided long-range forecasts about surface and groundwater supplies and monitored water quality. Prior to 2032, Congress periodically passed legislation that authorized federal agencies to help plan and build water supply, storm management systems, and wastewater plants for poor communities. After 2032, these communities applied to NIFA for funding and planning assistance. If the federal government provided funds and technical assistance, it stipulated that the project be developed within the constraints of watershed planning. Finally, the federal government assumed the responsibility of ensuring that infrastructure was protected against human or natural disaster (although the near disaster at Oahe suggested the limitations of this endeavor). Federal projects were fortified, and Congress allocated funds to non-federal governments and the private sector for reducing the vulnerability of projects under their control. Federal agencies oversaw the program and offered technical advice.

Western water problems drew particular attention. The peculiarities of the United States crop support program meant that millions of acre-feet of water were being used to support surplus crops of low value (except, of course, to the growers). At the same time, Western cities such as Denver, Reno, Fresno, and Sacramento practiced conservation measures only during times of drought and did not utilize water metering. Users paid flat monthly rates no matter how much water they used. The resulting problems were ones of quantity and quality and involved both surface and ground water. To alleviate the problem, the federal government worked with states and localities to promote conservation measures for both irrigation and domestic water supply. These included more attention to lining canals, installing pipelines, drip irrigation, metering, and the installation of debris collection systems and re-regulating ponds. An increasingly favored irrigation solution was microirrigation, whereby water was delivered through a system of plastic tubes laid across or just under the surface. Water release could be adjusted to match the approximate water consumption rates of plants, thus saving water otherwise lost as surface runoff. Federal agencies also supported improved management practices such as a limited irrigation-dryland system, in which the upper half of a field is fully irrigated, the next one-quarter uses runoff from the upper half, and the bottom quarter is managed as a dryland system solely dependent on rainfall. Moreover, by 2015 water marketing became common and received official federal encouragement. This meant that more rural areas and farmers sold their water to the cities (under the Western doctrine of prior appropriation, the first who used the water could claim the water and had rights to sell it). By 2020, Congress also had reduced federal water subsidies and cut back the crop price support program, although politics prevented phasing the programs out entirely.

The federal government expanded the 2010 alternative energy legislation, so that grants provided for scientific work in the study of critical processes affecting wetlands, for technological developments that would enhance stewardship and management, and for methods to identify and preserve healthy ecosystems. Among other innovations, advanced measurement tools used GIS technology and the analysis of wavefields. GIS technology was hooked to computers and satellite imagery to help locate ground and surface water. This technological synergy also helped visualize the necessary infrastructure for entire watersheds and the impact of that infrastructure on ecological systems a water flow. GPS and GIS data were integrated into radar systems so that everything from barges to planes could be tracked more easily. New computer models simulated environmental processes on scales that ranged from the microscopic to the global. As the models became more reliable, they allowed more accurate forecasting of environmental change, including climate change and global warming. By 2035, it was possible to predict with very little qualification what would be both the long- and short-term impacts of dams, locks, and other structures on entire watersheds and ecological systems—and to act accordingly.

Computers and remote cameras also helped create a nationwide transportation monitoring system with traffic control centers to manage the operation of all major area roads and to supply real-time information to travelers. A GPS for use by the nation's civilian aircraft eliminated dependence on radio beacons and simplified on-board avionics. Computers enhanced intermodal inland waterways transportation. Some of the new programs and devices included sensors to assist pilots navigating in fog; real-time depth information and systems to predict water levels and loading thresholds; a computerized knowledge base for the inland waterways system; tools to estimate the costs of moving a container from one terminal to another and to estimate fuel tax payments for the tow traffic; and the development of an electronic nautical chart for all navigable waterways. Finally, electronic decision support systems facilitated partnering and collaboration and helped identify problems earlier and implement plans faster.

Hard Times

Crises do not happen in 2035, but the effects of crises are everywhere. Terrorist movements contributed to the growth of isolationism and protectionism in the United States and the realization that the fight against ideology exceeded in some ways the difficulty of fighting against armed combatants. Changing weather patterns generated catastrophic storms in the Sacramento River Valley that broke levees and inundated vast regions. It also left behind a deluge of recriminations at all levels of government.

State governments did not have sufficient authority or funding to cope with infrastructure problems. They, therefore, encouraged federal leadership, and the federal government responded with the resurrection of a new and improved Water Resources Council to arbitrate disputes and provide water policy recommendations. Among other policy changes, the WRC encouraged the creation of river basin commissions around the country and the development of uniform national regulations dealing with water quality and quantity issues. Still, the WRC did little to advocate non-structural solutions, which generally met resistance from the public because of the expense, land restrictions, building requirements, and conservation measures, none of which seemed capable of offering permanent solutions for a growing urban population. Rather, especially after several periods of drought, governments at non-federal levels focused on using scarce funds for necessary water supply and wastewater systems.

Crisis also operated on the international level. An ill-advised campaign to vaccinate the population of Zimbabwe against a particularly virulent strain (serotype) of Dengue resulted in over one hundred-thousand dead, and an outcry from both non-aligned nations and some Western nations. The resulting political and economic blood-letting provided grounds for rising nationalism and isolationism in some countries and a re-evaluation of investment policy on the part of Western nations and private companies. Less and less funds went to the developing nations because of concerns about security and stability. By 2035, most of the world was in the grip of protectionism, and countries looked inward. The worsening political and economic climate meant even less money was available for water infrastructure as more government money was spent on defense, and more private investment was used to fund research and development and innovative technology. Technology was a bright spot in this generally dismal picture, as private and public organizations developed new tools and approaches that helped reduce financial requirements and improve education, industrial production, energy availability, water quality, communications, and defenses against chemical and biological contamination.

I. *All Rivers Lead to Washington*

John Wesley Powell suggested over a hundred years ago that watersheds might serve as better administrative boundaries than the arbitrary political borders established in law. Neither Powell nor his intellectual legatees had much success with their proposal. Instead, within the United States tens of thousands of governments within governments (Woodrow Wilson's term) had their hands in the establishment of water policy and

allocation. As population grew, more demands were placed on available water, and countless conflicts found their ways into courts, state legislative chambers, and governors' offices. While violence rarely occurred, the problems often seemed difficult to resolve in an equitable and politically acceptable fashion. The long-standing conflict over the Apalachicola, Chattahoochee, and Flint River system in Georgia, Alabama, and Florida epitomized some of the problems. So did growing problems in southern California and Arizona over the use of Colorado River water or between the upper and lower basin states within the Missouri River Basin. Even along the Canadian-U.S. border, disputes erupted over the use of the Columbia River and the Great Lakes, and sporadically the United States and Mexico disagreed over issues dealing with the Rio Grande.

In the early 21st century, these problems grew significantly as partisan politics, urbanization, and several years of drought combined to confront policymakers with apparently unmanageable and unsolvable problems. With annual average temperatures increasing, these droughts appeared more frequently in the eastern part of the country. New York City attempted to purchase water rights in Pennsylvania, Connecticut, New Jersey, and upstate New York and met more and more resistance. Atlanta faced problems as well. So did Miami and various smaller coastal cities that faced both population increase and threats from salt-water intrusion. Meanwhile, conflicts continued in the West over the allocation of water to various states and for specific purposes. Melting snow packs in the Sierra threatened floods but did not always provide water when farmers needed it. Problems emerged over reservoir storage agreements, with some states asking for more water to be retained for irrigation and hydropower, while other states argued for more releases for navigation and flood storage. Regional associations, some the result of compacts approved by Congress and others more or less ad hoc, attempted to resolve issues, but these associations had limited authority to coerce member states and/or cities to agree to the necessary compromises. Tempers flared, regional lobbying groups formed, and most critical issues remained intractable.

In 2021, the Council on State Governments (CSG) suggested increased federal involvement to cut through the stalemated discussions on water problems. The report noted that the federal Water Resources Council (WRC), established in 1965, had led to the development of river basin commissions and framework studies to investigate regional water needs. While the Council never had the support of the Office of Management and Budget and was eventually discontinued, along with the basin commissions, by President Reagan in 1982, it had served as an important forum for addressing regional water issues and for advising Congress of necessary projects for economic development and water needs. The Council's weakness, aside from lack of support from other parts of the Executive Branch, resulted from its domination by federal appointees and weak representation from the states. Could the federal government re-establish this Council, the CSG queried, but this time with considerably more state involvement and clout? The state governors debated the issue at the National Governors Association Conference in 2022, and voted to petition Congress to provide for a new WRC that would be headed by a federal Cabinet level department head, but would include representatives from state governments. The Council would have the power to

arbitrate disputes submitted to it and to monitor how well its decisions were implemented and report back to Congress.

Congress passed the implementing legislation three years later, in 2025. In subsequent years, as the WRC grew in credibility and competence, it arbitrated more and more disputes. Its staff of professional engineers, lawyers, and scientists grew proportionately. Many of the disputes resulted from inadequate water infrastructure and lack of funding. Questions often focused on how to do more with less.

WRC's credibility directly related to the quality of its staff and, consequently, the WRC actively recruited at the best institutions and successfully sought waivers from Congress to Office of Personnel Management restrictions on salaries and promotion and dismissal procedures. The Council's power grew, and its annual reports in which it made water policy recommendations received careful attention from Congress. The Council promoted the establishment of regional water basin commissions to oversee the program, but it insisted on establishing rules and regulations with national applicability rather than just concerning one basin. Other federal water agencies tried to anticipate the WRC recommendations and align their own accordingly.

II. *Pipe Dreams*

Globalization seemed so sensible, so inherently "globe-flattening", but in the end it was too good to be true. Of the three-hundred or so regional trade agreements signed since World War II, about 250 were signed in the period between 1995 and 2006, when "globalization" became a popular (or unpopular) term. Some fifty of them involved developing economies. Corporations set up shop abroad, used foreign workers, and, it was hoped, would stimulate economic progress in the still developing nations.

But even before globalization really started, problems appeared. The third world could not pay its debts to the West or even pay the interest. Third world economies ground to a halt, and GDP per person actually fell despite some private investment from abroad. Attempts in the West to alleviate the crisis led to partial solutions that sometimes further exacerbated the situation. For instance, some Western countries cut aid to health and education programs. Complicating the situation, nationalism re-emerged in the Balkans, Eastern Europe, and the former Soviet Empire. For nationalists, economic integration was anathema. It threatened national sovereignty. Such nationalism, it should be added, emerged in many Western countries as well, such as France, Germany, Japan, and the United States. Lending force to the argument of nationalists were the number of failed states and corrupt governments that threatened war on their own peoples and that denounced agreements which earlier governments had solemnly signed. Such nations could not be trusted, many argued, and should not be helped. What help many of these nations received came from non-governmental, non-profit organizations.

To a large extent, the success of globalization depended on the willingness of large corporations to invest abroad in both products and labor. Yet, at the first signs of globalization, an incident occurred that immediately raised alarms. In 1984 in Bhopal,

India, a Union Carbide plant suffered a major leak that resulted in the death of 3,000 people (same number of people as were killed in 9/11) within a few hours, 15,000 more in the aftermath, and injured 200,000. Five-hundred thousand people carried special health cards for decades, and the abandoned plant sat abandoned with 25 tons of toxic waste surrounding it. In the end, Union Carbide apologized and paid a settlement of $470 million. The entire episode kindled suspicion of both the competence and motives of large corporations. In ensuing years, much of the Third World's animosity was directed towards pharmaceutical companies, whose activities often seemed to contradict the widely-held view that health was a human right. When governments such as Brazil attempted to distribute HIV/AIDS drugs free of charge, the United States dragged Brazil before the World Trade Organization (founded in 1995) to protect corporate patents. After months of protests, the United States withdrew the complaint. Still, pharmaceutical companies continued to generate complaints about their insensitivity to the public good—in developing countries and elsewhere.

Partly the result of the installation of their takeover by radical, anti-Western governments, resource-rich nations threatened to restrict access to oil, gas, and other vital resources. Some countries readily use their control of resources to promote their own policies. The rise of anti-Western resource-rich nations helped to promote the use of alternative fuels and innovative technologies in the West, but at its best it disturbed market forces, which these countries embraced only when opportune. Other nations imposed strong environmental controls on resource exploitation, but their implementation often seemed curiously opportunistic and arbitrary. It was difficult to discern the boundary between environmental concerns and narrow international political agendas.

In the ten years from 2008 to 2015, international trade agreements were either not renewed or were modified to allow signatory powers more independence. Some third world nations refused to allow Western companies to operate within their borders or imposed onerous regulations on them when they did. Matters came to a head, finally, in 2016, when a large U.S. pharmaceutical company, working with a Thai medical research center, developed a vaccine against a particularly virulent strain of Dengue (there are four strains or virus serotypes; vaccination against one does not provide protection against the others). It offered to vaccinate free of charge the entire population of Zimbabwe with this newly developed vaccine. The decision led to tragedy. Over 100,000 people died directly from the vaccination. When company executives flew to Zimbabwe to investigate and to apologize, they were immediately arrested (much as the Union Carbide CEO was arrested when he arrived in India after the Bhopal disaster, but he was shortly released). The United States protested but to no avail. Non-aligned countries threw their support behind the Zimbabwean government, and even some Western nations expressed support. Finally, two executives were sentenced to 20-year prison terms, one to a three year term, and three more paid multi-million dollar fines before they were released (of course, the company paid the fines).

In the wake of this incident, many countries, including the United States, reduced their commitments to help Third World nations, and private companies gradually retreated from promises of investment abroad. Nationalists gained the upper hand in a

number of nations, including several in Europe. The United States saw a general retrenchment in favor of protectionism and autarchy. Islamic nations, sensing isolation from the West and suspicious of Western politics and culture, withdrew from any agreements with the West and signed various mutual aid pacts, setting aside the various schisms that had divided the Muslim world. Their position was a noteworthy deviation from that of a former American Secretary of State, who had said in reference to an invasion of an Islamic state: "We shall act even if others are not prepared to join us." At the time, the message was clear: nation-states rule; economics and culture do not. In the Islamic world, however, both nation-states and culture ruled.

By the 2020s, protectionism emerged, and cultural fault lines divided peoples and civilizations. Concerns over human rights dwindled, corruption increased, and transparency was non-existent in certain countries. Territorial and resource disputes, economic dynamism, and cultural clashes led to significant increases in the military budgets, especially in Southeast and Central Asia. To keep America strong, the U.S. military budget constantly expanded at the cost of reduced funding for social services and discretionary programs.

The deteriorating global economic and political condition invariably affected domestic U.S. economics. Tax revenue decreased as the contraction of the global market reduced U.S. private sector profits, and structural economic and financial imbalances grew. The deficit (including state and local governments) grew to 15 percent of the GDP (from about 5 percent in 2005). Real wages declined, and debt in the U.S. quadrupled from its 2005 mark of some $50 trillion. Individuals declared bankruptcy, and states repudiated their debts (as they did in the 1840s). Retirees could not live on fixed incomes, and suicides among the baby-boom generation increased. The American trade imbalance left huge amounts of dollars abroad, especially in Asia, where they helped finance the growth of Asian industrial capacity. Asian goods sold back in the U.S. at cheap prices allowed the Federal Reserve to hold down lending rates and gave consumers the credit they needed to buy houses they could not really afford.

Finally, the American dollar decreased in value. Inflation contributed to the problem, as the U.S. Treasury began to print more money to reduce the value of America's debt (much like Germany did after World War I). Foreign banks unloaded their dollars as fast as they could, and U.S. citizens attempted to convert dollars to Euros and other currencies. In 2029, exactly one-hundred years after an earlier depression had nearly ripped the country apart, America stood at the abyss of another, and possibly, greater depression.

Under the circumstances, there was little funding available for infrastructure work, and the work requirements that had built up for over a decade remained. Decaying infrastructure deteriorated into unusable pipes and unsafe dams. Sinking levees remained below project grade. Except for channels deemed necessary for national defense, navigation channels were poorly maintained; inadequate channel depths and other navigation obstacles impeded waterway traffic. Road surface cracks were unfilled, and even airport runways became vulnerable. Growing cities could not obtain enough

water, and water conservation became routine, with certain kinds of water use seriously restricted. Private firms that had invested in infrastructure and had even agreed to operate infrastructure on behalf of certain municipalities threatened to turn the water off if they were not excused from their obligations. Some cities sued, but most reached some sort of agreement with the private firms. Future control and operation of infrastructure facilities remained uncertain. Politicians considered whether the Army Corps of Engineers or some other agency could run municipal facilities until a more permanent solution could be found. Under the circumstances, little attention was paid to security, and the nation's infrastructure invited attack by even the most amateur of terrorists.

The silver lining in all this was that the times really did prove that necessity is the mother of invention. Private firms, either with or without governmental support, sought scientific and technological "fixes" for some of the pressing problems of the day (and eagerly applied for patents on each new advance). While not nearly enough money was available to promote major progress in the so-called hydrogen economy, technological advances allowed for more efficient use of wind, solar, and geothermal power. Ethanol and other biomass-based fuels complimented oil and gas. New turbine designs stimulated the increased use of hydropower. At the same time, other technologies and conservation practices reduced industrial energy consumption per unit of production. By 2035, alternative fuels supplied 45 percent of the total energy market. In other technological areas, advances in nanotechnology led to new ways to reduce waste production, use resources more efficiently, provide potable water, and reduce industrial contamination All these advances came through improved membranes, contaminant sensing, energy storage, catalysis, and contaminant immobilization. Another promising field, genetic research, led to the capability of insulating the human body from various kinds of environmental exposures. Finally, the information revolution linked people and organizations around the world. The revolution had begun in the late 20th century, but subsequent developments, coupled with GIS and other computer-based technologies, proved truly empowering to organizations ranging from non-governmental advocacy groups to terrorist organizations of all sizes. Huge networks linked organizations that focused on environmental, human rights, and other issues. Although the danger coming from terrorist groups could hardly be discounted, by and large these communications networks proved a major asset in democratic societies.

One development that proved especially rewarding was the use of the Internet for formal classroom instruction. While this pedagogical innovation had already started at the beginning of the century, it became commonplace by 2035; many college, high school, and middle school classes were taught via the Internet. The approach provided excellent teachers for all students, significantly reduced the number of mediocre teachers, and allowed a greater portion of school budgets (severely constrained in a depressed economic climate) to focus on construction and maintenance. It also allowed NGOs, private industry, and government agencies to provide Internet courses, fully accredited, on everything from ceramic technology to sailing. Federal water agencies provided well-received courses on hydrology, water planning, and disaster relief and recovery.

III. *Running for Cover*

It happened on 17 September 2030, but the preparations must have begun a decade earlier. In the early morning on the Nevada-California border, the unthinkable happened. An explosion ripped apart Hoover Dam, sending a wall of water 300 feet high ripping through Black Canyon and, moving downstream on the Colorado River at an amazing speed, wiped out every dam below Hoover as though they were made of match sticks. Immediately, Las Vegas was plunged into darkness, without electrical energy or adequate water. Communities in southern California also suffered major rolling blackouts. Then about 9 a.m. Eastern time, soon after the Hoover blast, people in Washington, D.C. became violently ill after drinking tap water, and within hours 5,000 people were dead. Back in the West, somehow terrorists managed to get into the main dam structure at Bonneville Dam, where they set off another explosion that tore the dam open and sent Columbia River water downstream, bringing flooding to Portland and other downstream cities. The hydropower facilities remained, but with and insufficient head of water to run them efficiently. Much of Washington and Oregon ground to a halt.

That evening, as commuter traffic crossed the Golden Gate Bridge—swollen by alarmed people trying to get home a bit early—a seemingly despondent person walked along the narrow walkway that had been suicide alley for over a thousand people since the bridge had opened nearly a century before. There were signs on the bridge advising the depressed to call a hot line, but few who traveled along that walkway paid attention, and the people who drove over the bridge, intent on getting home, hardly noticed one more jumper. Suddenly from the backpack he carried, he took an explosive device which he swung below the bridge with an attached chain. Coated with some sticky substance, the well-padded device immediately stuck to the underside of the superstructure. Twenty minutes later a massive explosion sent the mid-section of the Golden Gate Bridge into the swirling bay waters. About 250 people lost their lives. Within the space of twelve hours two of America's most prized iconic structures had been destroyed. The U.S. was at war, but with whom?

Within a day, an organization claimed responsibility. It was the United African Movement (UAM), an organization of Africans who came from the sub-Saharan countries, the fastest growing region in the world. The region witnessed steadily growing poverty, high mortality rates brought on by AIDS and other diseases, and corrupt governments. With all its problems, however, Southern Africa seemed to be ignored by the rest of the world. The UAM was formed to bring Africa's problems to the attention of the world and to restore pride in being African. It transcended tribal lines and community barriers and brought together people from throughout the region. Soon after the horrible events in Zimbabwe in 2016, a radical fringe of the UAM decided to wreak revenge on the United States. They embedded members on the staffs of the Washington, D.C. Water and Sanitation Commission and the Bureau of Reclamation at Hoover Dam. Others were trained to act as tourists; they joined the tour of Bonneville Dam until they stole off for an excursion that sent them to eternity. The lonely would-be suicide on Golden Gate Bridge was easy; suicides were just too common.

The nation faced devastating losses, but was without the wherewithal to do much. It repaired the various structures only with major assistance from foreign countries that provided funding, technical assistance, and material. The work on the Golden Gate Bridge and Hoover Dam lasted more than three years, but the emotional scars and wounded national pride lasted much longer. In Washington, D.C. local and state agencies reviewed security measures, which were found lacking. Indeed, confusion existed at first about whether the Washington water supply had been contaminated by chemical or biological agents. It turned out to be a chemical contaminant. Still, no one could figure out how to prevent a disaster resulting from an embedded employee who had earned trust and respect over a ten-year career. As for the UAM, they were not a military outfit, had no army, and their principle weapon was their ideology. There was no one to fight. Protests were made, ambassadors were withdrawn, but within five years the former relationships were restored. The more lasting result was even more reluctance on the part of American firms to invest in the sub-Saharan region.

IV. *Climatic Crisis*

The first decade of the 21st century saw an acceleration of the atmospheric warming that had begun the century before. Average temperature increase ranged from half a degree to a full two degrees in some hard-hit areas. Most of North America experienced thirty percent more days with peak temperatures above 90 degrees Fahrenheit, with far fewer days below freezing. By 2010 float ice in the northern polar areas was largely gone. Glacial ice melted, sea levels rose, and ocean waves increased in intensity. Melting mountain glaciers forced people in Central Asia and Canada to move. However, in the United States, the climatic shift in the first decade was considered a simple nuisance and not enough to generate worries about national security and GDP.

A strong storm surge threatened the Dutch levees in 2009, but recent Dutch efforts to strengthen the coastal levee systems, the result of sophisticated model studies of perturbations in weather patterns and changes in North Sea water levels, prevented anything other than some localized flooding. Other factors that helped reduce the flood hazard included logistics, early warning, and communication systems that effectively coordinated local and federal efforts and continued reliance on the 10,000 year flood risk standard for storm surges.

In the second decade of the century, climatic change accelerated. A collapse in the thermohaline circulation (the so-called ocean conveyer belt) disrupted temperature climate in northern Europe and the eastern United States. Average annual temperature dropped by as much as 4 degrees Fahrenheit in some parts of the eastern United States, and rainfall dramatically declined in many areas. Drought enveloped much of the eastern United States, and winter storms and winds intensified. Under-staffed, under-funded, and uncoordinated, agencies at all levels of government in the United States could not provide accurate and consistent information or prepare responses. Various computer models could not be reconciled, and policymakers were left wondering whether the weather changes were long- or short-term. The impacts of drought were most dramatic. Some lakes dried up, river flow decreased, and fresh water reserves were seriously depleted, as

a growing population and uncertain government overwhelmed any conservation efforts. The growing season became shorter, colder, and drier in the Northeast.

Meanwhile in the West, desert areas faced more windstorms, while agricultural areas faced severe soil loss due to higher wind speeds and reduced soil moisture. Relatively fast-melting glaciers contributed to flooding on the both sides of the Sierra Nevada range. Coastal areas around the United States were at increased risk, as rising ocean levels threatened catastrophe. The United States turned increasingly inward, focusing on feeding its own population and shoring up a disintegrating infrastructure as best it could.

A particularly cataclysmic event occurred in 2028. For several years, sudden storms, mixed with glacial ice melt, threatened the Sacramento River Delta in California. Some levees had been undermined and had not been repaired, and lack of funds prevented maintenance of other structures in the flood control system. On 25 February, the first in a series of massive storms swept northeastward from the Hawaiian Islands, bringing with it the vaporized moisture it picked up as it moved over warm ocean water. In a fifteen day downpour, one storm system after another dumped incredible volumes of rain on a broad swath of land stretching 200 miles north and 100 miles south of a line stretching from San Francisco to Sacramento and Lake Tahoe. The Truckee, Russian, and Napa rivers all swelled until there was uncontrollable flooding in some areas.

In the Sacramento Valley, the Sacramento River's main channel was soon over capacity. North of the Sutter Buttes, Chico Creek overflowed. Further downstream on the Sacramento, excess waters poured over Moulton and Colusa weirs, joining southward flowing water from Butte Basin. Meanwhile, the Feather River and Yuba rivers reached a seventy-foot flood stage within six days after the first storm. Necessary releases from Oroville Dam poured a torrent of water into the Feather River.

Around Sacramento, volunteers worked day and night to strengthen levees along the American River. The stream was rushing along at over 140,000 second feet, bringing huge volumes of water into the Sacramento River. At first the levees held, and the waters went through the Sacramento Weir and on into the Yolo Bypass. But finally true disaster struck. First the levees on the Sacramento River broke. Then Folsom Dam was overtopped and partially collapsed; downstream from the Dam, American River levees fractured. The Sacramento Airport was under water. Row PP in the upper deck marked the waterline in the sports coliseum. Around one million second feet of water destroyed much of what had been built up over the last thirty years. Homes and businesses were inundated, and the region around Old Town Sacramento devastated. Indeed, the water reached the grounds of the state capital. Altogether, more than 350,000 people had to be evacuated. Many of them lost their homes. Ten-thousand people died.

The barely imaginable became worse before it got better. The failure of the delta island levees along the lower Sacramento River allowed salt water intrusion that threatened water supplies to southern California through the California aqueduct. During

the dry season, the water could not be used until expensive equipment was in place to reduce the salinity.

The entire episode placed an enormous burden on all levels of government, and much bickering ensued about both the responsibility for the disaster and the division of effort necessary to restore the area. Eventually, most accepted the recommendations of the WRC to leave some areas uninhabited and to move levees and floodwalls further away from the river to allow for greater volumes of floodwater to pass. However, calls to remove whole communities from the San Francisco Delta area met stubborn developer and political resistance and failed to make much of an impact. Still, the WRC recommendations proved prescient, as in the coming years the Sacramento Valley continued to experience violent weather patterns.

Appendix D Key Success Factor Analysis by Business Program

Business Line Legend: N=navigation; H=hydropower; F=flood damage reduction; R=regulatory; E=environmental restoration or environmental stewardship; W=water supply; D=emergency management and disaster recovery; U=fusrap; P=natural resources and recreation; G=from general discussion-not business line specific

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
Develop and Manage Strategic Alliances				
Maintain/forge partnerships at all levels. Develop strong relationships with other water management agencies. Maintain relevancy with state and local partners. Develop collaborative relationships with science and technical universities and those with active water resources programs. Partner with non-federal entities to implement environmentally sound solutions through watershed planning and reservoir reallocation procedures. Expand partnerships with other agencies such as USAID and increase visibility within DoD	G, E, W, U	G, E, U	E, W, U	G, U
Find a niche as a broker to combine funding and technical assistance among the federal family	G			
Capability to do engineering design virtually, across the globe, through public-private engineering collaboratives.	G			
Have an increased emphasis on 'other people's money', more aggressive support for others		G		
Collaborate operationally with state and local governments to meet federal reliability requirements	H			
Partner with private interests to capture offshore wave energy	H			
Look to other parts of the world for current R&D, where hydropower is still being developed (China, Brazil, Africa)	H			
Cooperate with state/local governments to do "easy" permits	R		R	
Provide planning, technical assistance, and tech transfer to state/local governments and other partners	E		E	
Move focus of EM to international: Expand collaboration with USAID and send our people overseas to do response work; explore authority to engage in international response under own authorities	D			

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
Build partnerships with other agencies. Bridge between states and localities to reduce local/interstate tension. Use CMEP experience to facilitate partnerships between different nationalities/groups/localities.				D
Maintain response capabilities with less people by leveraging other agencies better.				D
Develop better coordination with states and locals, who will be managing more of the response, in collaboration with FEMA	D			
Use expertise in hazardous, toxic, and radiological waste management and remediation to do similar work for other agencies and foreign governments.	U		U	
Assist DOE with legacy management issues and NRC with reactor closure issues, both operations and environmental	U			
Change role from landlord to partner with outgrant lessees.	P			
Understand and Communicate Risk				
Hold a national dialogue on infrastructure priorities, risks				G
Do a better job of communicating risks and consequences		G		
Use and train others in risk-based approach to FDR decisions	D			
Build risk analysis capability and increase capability for risk-based decision making			D, G	G
Operate Cost Competitively, Efficiently				
Centralized production (to retain technical expertise), decentralized execution	G		G	
Investigate consolidation/regionalization/interdependency		G		
Have a greater focus on nationalization (vs. regionalization) to reduce overhead. Promote geographic capability and virtual arrangements for key technical staff.		G		
Standardize our procedures—national policies and regional business processes. Regional operations with national standards.			G	
Become more efficient in infrastructure maintenance, repair and replacement, due to limited funds		N, G		N

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
Become very good at quick repairs to restore function after breakdowns and failures		N		N
Develop contingency plans for rerouting goods when navigation facilities are down		N		N
Concentrate resources on higher-use portions of the inland navigation system; may need to abandon lower-use parts.				N
Emphasize watershed approach and concentrate federal efforts on major projects with significant environmental impacts	R		R	R
Change training, move NWP/RGP authorizations to locals/states	R		R	R
Increase R & D on less expensive patchwork fixes		D		
Attract, Train, Develop, Retain, Reward Workforce				
Job exchanges with other agencies, the private sector, universities, international organizations to foster interoperability and appreciation for each group's culture.	G	G		G
Create incentives for innovation, accountability, and performance through NSPS		G		
Hire more skilled facilitators, coastal engineers, and MBAs			G	G
Ability to retain staff with FDR technical competency when there is no traditional work in the U.S.—possibly send them to other countries for nation building missions Use OCONUS opportunities to keep the EM CoP sharp and engaged.	F	D		
Train staff to be decision makers, make hard decisions, balancing development and environment	R			
Take advantage of strong environmental values and technological innovations; increase number and expertise of personnel working on environmental stewardship			E	
Retain/enhance core planning/negotiating skills				E
Build arbitration skills to foster integrated natural resources management				E
Restructure staff from operational to flex capability; Prepare for increased role in technical advising; provide incentives to technical experts who act in advisory roles rather than in operational roles	D		D	

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
Encourage cross-functional training and roles for employees		U		U
More integration of HTRW personnel with Emergency Response personnel			U	
Provide training in new technologies and associated environmental impacts, especially short-term acute exposure vs. chronic exposures. Expand environmental support team and forward engineering support team training for environmental personnel and others.			U	
Include the requirement for emergency operations mobilization in job descriptions			U	
Develop, Store, and Transfer Mission Area Knowledge				
Strengthen environmental management capability	G		G	
Ability to compete for funds by producing quantitative program benefits. Ability to measure economic benefits of FDR projects, and communicate these to decision makers. Work to assign a monetary value to environmental benefits, a common basis for use in prioritizing outputs of environmental projects.	N	N, F	E	
Improve data collection, forecasting, and scenario planning to determine impacts on the existing infrastructure and enhance our business management skills			G	
Use new information networks and data systems to streamline the permit process and to document impacts in decisions, use ORM-2 to take advantage of new networks and coordinate among federal agencies and others.	R	R	R	R
Define limits for cumulative impacts in specific watersheds	R		R	
Use hydrologic and other types of modeling to tie projects, assess cumulative impacts, predict impacts of environmental restoration projects.	R		E, G	
Better utilize CoPs to share information across program lines	U	U	U	U
Ability to expand and contract operations rapidly; maintain a flexible, agile business structure	G	G		
Ability to switch gears from breakdown maintenance	N		N	

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
to preventive maintenance				
Ability to handle wild fluctuations in cargo, caused by external forces (drought, GMO controversies, changes in use of fossil fuels)			N	N
Limit inhouse engineering and design; contract for hydropower asset management expertise with private sector		H		
Train locals in operations and emergency response skills	F			
Expand emergency response capability with a trained, ready, deployable workforce.			G	D, G
Form an expandable disaster management capability by supplementing regular staff with a network of "Auxiliary Corps workers". They are located across the nation and are paid a small amount to be on call for disasters. When deployed they are paid full salaries by USACE and given leave from other jobs, like a civilian reserve force.				D, G
Lead in Application and Transfer of Selected Technologies				
Offer a spectrum of Green Design as a product for technical and planning assistance to states	G			
Build more resilient infrastructure				G
Encourage renewable energy development through streamlined permitting		G		
Create an intelligent inland navigation system, using modern technology to capture data, performance measures. Also use this information technology to manage traffic and move more goods through the existing system.	N	N	N	N
Ability to adapt navigation system to new energy sources, such as hydrogen fuel cells			N	
Ability to keep navigation system running with less water due to drought, other competing water uses (variable draft vessels and barges)			N	N
Make beneficial use and regional management of sediment/dredged material the norm	N		N	
Find cheaper, better ways to transport sediment/dredged material	N		N	
Learn better ways to deal with contaminated dredged material, particularly beneficial uses	N		N	
Extreme beneficial use of dredged material like	N			

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
creation of waterfront property, islands, gated residential communities, as well as creation of wetlands for wildlife and storm buffers, even carbon credits.				
Learn about and implement more efficient hydropower technologies in environmentally-sensitive waterways (instream turbines, driven by tides and streamflow, low head hydro)	H			
Develop and fund a hydroelectric design center, through ERDC	H			
Use technology to streamline project operation (remote control of large plants) and to produce hydropower more efficiently				H
Learn how to utilize fluctuating water supplies and extreme climactic conditions for hydropower				H
Ability to develop, update, and enforce standards, perhaps through R & D on remote sensing inspection and monitoring techniques.	F, G		F	F
Expand R & D for real time operations, including emergency response	F	F	F	F
Hone expertise in extending the life of geriatric projects through new repair and rehab technology		F, G		
Increase R & D in the areas of innovative response			D	
Transfer technology/expertise to emphasis on fossil fuels.		U		
Utilize lessons learned to provide support to developing nations to avoid repeating past ecological mistakes	U		U	
Customize and Innovate Financing				
Leverage resources within the federal system		G		
Obtain authority to move money to adapt to rapidly changing needs				G
Think of navigation as a revenue opportunity; attract new cargos.	N		N	
Shift to direct funding, utilizing hydropower revenues to pay for critical O & M and rehab.	H	H		
Implement full-cost pricing for recreation services, and capture the revenue for maintenance and construction of new facilities.	P			
Renegotiate sale of our hydropower as peak power rather than base load (higher value)	H			

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
Charge for processing of bigger permits	R			
Use non-traditional funding for stewardship efforts on public land, through greater NGO participation	E			E
Explore how to expand the EM program to provide grants to local responders	D			
Catalyze Solutions to Water Resource Problems and Conflicts				
Be a leader in watershed management, through collaboration, data sharing and project execution. Mature our system-wide approach using watershed-level thinking, build this into our culture. Act as facilitator in watershed groups.	R		G, R	G, E
Build capabilities in collaboration and integrated water resources management**,** less stratification of business lines, more regional teams	G, E		E	G
Ability to resolve conflicts over water use, negotiate and manage trade-offs between different water uses (flood storage and water supply, for example), perhaps renegotiate treaties and other water agreements, "honest broker role". Take the lead in administering a federal inter-jurisdictional arbitration panel to mediate disputes over water conflicts.	G		G	H, F
Balance basic human water needs, protection of life and safety, wildlife habitat, wetland protection, economic issues. Make honest, balanced environmental decisions that are legally defensible; be the nation's honest broker and environmental decision maker	R	R	R	R
Use a comprehensive approach to natural systems and economic development	E			
Integrate ecosystem restoration with higher priority projects that meet critical needs, like FDR or navigation		E		
Prioritization of work				
Develop a prioritization process with broad, agreed-upon criteria to identify what is really essential, in context of increasingly restricted funding.		G, U		G, U
Regional investment prioritization		H		
Develop skills and tools (up-to-date knowledge of assets, including their condition) for asset management. Use asset management to prioritize	N	N, F	G	

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
and optimize program execution. Use it to identify priorities for repairs to protect life and safety.				
Learn how to become a good grant agency; use principles of integrated water resource management to prioritize grant applications; take advantage of this change to implement portfolio planning			F	
Focus on life, health, safety infrastructure				E
Take advantage of the high priority of water supply in terms of human needs; be ready to expand the water supply program		W		W
Prioritize existing authorities and policies to execute the most critical with limited resources		D		
Prioritize our response/recovery missions along with FEMA; focus only on EM activities that are truly life-saving/life sustaining (no more ice/extensive debris missions)				D
Preparedness				
Develop and test evacuation plans for potential flood control structure failures.		F		
Incorporate climate change and a new hydrological regime and raised sea levels into design of new coastal protection for cities.			F	
Develop new RGP for disasters with restrictions on rebuilding		R		
Ability to increase protection of facilities; Harden and secure facilities				H, F
Prepare for/respond to climate change and associated fluctuations in precipitation by building more reservoirs to provide adequate storage for water supply (single purpose) and water supply infrastructure			W	
Focus on preparedness. Be ready to respond to disasters in a flexible way, could be federal coordination with regional and local execution.		D		G
Help locals reduce their flood risk through non-structural means (land use planning, buyouts, floodfighting training, evacuation planning)		D		
Expand infrastructure protection programs/underlying policies				D
Transfer technology/expertise to emphasize issues with alternative fuels, biological and chemical warfare. Integrate with existing biological/chemical				U

Key Success Factor	P of P	CrkngUp	New Or.	HdTms
warfare teams.				
Miscellaneous				
Develop a strategic image maintenance plan		G		
Address the issue of public trust				G
Develop a new niche for hydropower, to offset more expensive new forms of energy	H		H	
Be prepared to actually remove some dams, in a safe and environmentally acceptable way			H	
Prepare infrastructure for divestiture to non-Feds	F			
Retain an environmental ethic in disaster recovery operations				R
Increasing need for coastal wetlands precludes some development and enhances role of mitigation banks			R	R
Increase environmental stewardship education and public education/outreach on the benefits of integrated and balanced management to achieve multiple purposes		E		E
Concentrate on our unique niche—water-based recreation within 50 miles of urban centers	P			
Manage our lakes in a regional context, i.e. provide incentives for recreationists to move from crowded lakes to empty ones.	P			

Appendix E Strategic Segment Descriptions

Segment A - Do It For Me – This segment includes customers that want a turnkey solution implemented by some type of engineering organization because they lack the required in-house skills or are too busy with other required work to spend time developing new projects. Generally a single community, county, or state agency will ask that engineering organization to plan, design and construct a cost-shared public works project that meets their needs. The customer is expecting the engineering organization to take a leadership role in developing conceptual designs, conducting the feasibility studies and gaining the support of the public, conducting the necessary environmental evaluations, obtaining permits and approval from the appropriate resource agencies, producing the required reports and design documents, and arranging for the funding, procurement and construction of the selected project. These projects are usually of limited scope and meet a specific local need. Most of the completed projects are turned over to the sponsoring local government entity for operation and maintenance. However, the federal government is responsible for a large number of legacy projects requiring O&M to include care of existing river and harbor, flood and storm damage reduction, aquatic ecosystem restoration, and related projects authorized by law; for providing security for infrastructure owned and operated by, or on behalf of, the United States Army Corps of Engineers including administrative buildings and facilities, laboratories, and the Washington Aqueduct; for the maintenance of harbor channels provided by a State, municipality, or other public agency that serve essential navigation needs of general commerce, where authorized by law; and for surveys and charting of northern and northwestern lakes and connecting waters, clearing and straightening channels, and removal of obstructions to navigation.

These public works projects range from local roads to potable water facilities to flood damage reduction projects and recreation areas for the public. This infrastructure is vital to nation's prosperity and quality of life. Most of these projects are built under the Continuing Authorities Program. These are small turnkey projects for flood damage reduction, navigation, shoreline protection, streambank protection, navigation project impact mitigation, clearing and snagging, aquatic ecosystem restoration, project modifications for improvement of the environment, and beneficial uses of dredged material (including beneficial uses for environmental purposes as well as beneficial use for coastal storm damage reduction).

Public visibility is high on these local projects since the planning phase engages many local residents and a large number of communities that typically work closely with their Congressional Delegations to obtain support and funding for the projects. These projects are also faster to implement than regional projects and they clearly demonstrate tangible results from public expenditures for public works.

Segment B – Cater to Me (I'm in Charge) - This segment includes customers that are highly sophisticated and have the means to carry out their needs independently. They are peers with the District business program missions. They have an experienced capable engineering organization with in-house planning, design, construction and maintenance

capability. Examples are a large Port (Port of Oakland, NYNJ Port Authority, Port of Houston, Port of Los Angeles); or Flood Control District (Santa Clara County Flood Control, San Joaquin Flood control District County, Harris County Flood Control District, South Florida Water District). Their project needs are usually complex, large in scope and require integration and coordination with state and federal agencies. These projects can be either local or regional in scale, in either case they are slower to implement due to their complexity, scale and public visibility.

Even though the segment B partner is capable of carrying out their mission alone, they have strategically partnered with USACE to leverage their capabilities. This segment may want to shield their organization from liability by using national standards and knowledge; leverage their funds with federal dollars for infrastructure development; and or enhance execution to meet their business plan or carry out their state and federal mandates.

Segment B customers expect to leverage their capacity and development plans as an organization and as a result expect a leadership role in tailoring the project or program to meet their development needs. In many cases, they have purposely decided from a business and political perspective it is pragmatic to partner with USACE. However, they may be highly critical partners because there is a risk of losing their capability to do it alone if the partnership fails and or they may be investing in other components of a larger redevelopment plan that is dependent on the project being executed under the partnership with USACE. Consequently, they are highly sensitive to execution commitments associated with cost and schedule.

Depending on their plans, they are capable of providing leadership in place of USACE for all or some portion of the project life cycle. Technical capabilities include planning, engineering design products and construction, conceptual designs, conducting the feasibility studies and gaining the support of the public, conducting the necessary environmental evaluations, obtaining permits and approval from the appropriate resource agencies, producing the required reports and design documents, and arranging for the funding, procurement and construction of the selected project.

This segment is highly visible but in significantly different ways depending on the type of infrastructure. First, on large scale local flood control project, since the planning phase engages numerous communities involving local residents and real property issues, they are highly engaged in the decision making process. This type of engagement and visibility requires sophisticated community planning at the local level.

Second, the project may be high visibility but with less local resident participation, as is the case with major ports. These entities tend to be more business-minded, and have the attention of major corporations that depend on their services (pipeline-owning companies, port services companies, shipping companies, etc.). This also tends to draw the attention of NGO’s that are more interested in national issues. In either case, customers work closely with their Congressional Delegations to obtain support and funding for their projects.

Segment C – Do it with Me - In this segment, customers recognize they do not have the capability to carry out their programs or mandates independent of other state and federal agencies. Consequently, customers in this segment operating on a regional and or systems level require complex inter agency collaboration, consensus building and an integration of state and federal policy and planning processes. In general, these regional programs are collaborative by nature, are highly technical and complex; require substantial funding and time commitments. Generally they are complimentary federal programs that include customers from EPA, Interior, and NOAA Regional Office(s) or state agency(s) attempting to complement and or optimize their water resource mandates with other state and federal programs.

Like segment B, the Segment C customer has strategically partnered with USACE to leverage their capabilities. Unlike B who may be able to do it alone, this segment is characterized by multiple state and federal partners that determined they can not do it alone and consequently want us to work with them towards common goals and objectives. Examples: Columbia River, Inter coastal waterways, MR&T, LCA, Great Lakes, Western Water Study, Chesapeake Bay. Due in part to a lack of a national water policy, various federal partners might have pieces of authorities and missions, but no one can do it alone. Consequently, in some cases, customers are bringing fragmented local water policies together to provide a comprehensive regional solution seeking consensus across multiple players. During the implementation phase, they recognize they have limited in-house planning, design and construction capability and recognize USACE as a valuable partner due to our execution capability.

Multiple players sit shoulder to shoulder sharing in delegating responsibilities in the execution of the collaborative program. The customer is expecting to leverage their capacity and program plans as an organization and as a result expect a shared leadership role to ensure the program is tailored to meet their program needs. They expect USACE to act as a collaborator contributing towards multi program integration through objective analysis, balancing/resolution of conflicting demands, and institutional leadership. Collaborative partnership products include Programmatic EISs, Multi Objective Comprehensive Master Plans characterized by shared and independent Federal appropriations.

This segment is highly visible locally, regionally, and nationally because multiple state and federal missions are combining together at a regional scale to tackle complex water resource problems that are unsolvable without the partnership. They are multi objective and consequently engage numerous diverse stakeholders. Because they are trend setters with high visibility at the regional and national levels, the programs are of great interest to NGO's who are both involved directly in the program or are interested in national implications to policy and planning.

Segment D Save Me - : This segment includes USACE support for natural and manmade disasters. Segment D customers, both domestic and foreign, need a wide range of capabilities to prevent, repair and/or replace valued infrastructure systems that may be

susceptible to and/or damaged as a result of a natural and/or man-made disaster. Generally, these customers lack the necessary organizational, project management and response capabilities to write comprehensive emergency prevention and/or response plans nor have the resources available to respond during and/or after a disaster. A particular skill set they are lacking is the one related to "marshalling resources" to orchestrate resources – leadership, organization, people, communication, equipment and supplies – in a responsive, efficient and effective manner to alleviate further damage to their infrastructure and pain/suffering by the public. The needs of this customer are generally throughout the entire spectrum of emergency preparation and response including prevention, safety and security of their people and infrastructure, and on-the-ground response during/after an event regardless of its magnitude. In some cases, their needs will be in specific areas in which USACE can provide professional engineering, planning and project management skills to solve specific shortcomings. Ideally if they identify their needs early enough, their primary requirement will be to develop broad contingency planning and response scenarios for a wide variety of possible disasters. More than likely, this customer's needs will be for immediate and direct response during/after a disaster has devastated their homelands. In many cases, the immediate response will require professional engineering skills in a variety of disciplines including nuclear, electrical, geotechnical, civil works, structural, and mechanical engineering to identify and minimize potential hazards to provide the opportunity for emergency response personnel to quickly and safely respond to protect life, limb and property. This customer may have some resources available to provide assistance during specific phases of the emergency response process but generally has little capability to efficiently and effectively respond to a natural and/or man-made disaster.

The U.S. Army Corps of Engineers has a long and respected history associated with responding to natural and man-made disasters regardless of the level of response required to prevent, minimize and/or effectively manage emergency responses to protect life, limb and property. In domestic situations, strong partnerships currently exist with a few other federal agencies but opportunities exist to further enhance these relationships and create new ones. In foreign situations, there are a few specific examples including the Civil and Military Emergency Planning (CMEP) Program which could be modeled to other locations and provide many established and developing countries with these much needed services.

Segment E: "Complement Me" – This segment includes USACE Support to International Governments. Customers are typically from foreign nations that need specific assistance from a professional engineering organization that is familiar with the scope and breadth of large scale projects. Generally they have many of the skills and capabilities to complete phases of projects but are lacking the leadership, project management, and overall supervision capabilities that are required over the long run of design, construction, maintenance and sustainable life-cycle of large, complex projects. These projects are usually very large in scale, complex in engineering and environmental requirements, and have significant impacts on major populations. Typically, these projects form the backbone of infrastructure in these countries and have significant impacts on political, social, economic, environmental and quality of life issues. The

customer is in need of an engineering and management organization that can provide multiple skill-sets support in various facets of the project process, while generally remaining in the shadows thus providing the customer with a strong leadership face to their nation. These projects have been identified and accepted by the host nation as critical to their development on the world stage, crucial to their national economy on the global, regional and local scale, and will provide their nation with the greatest opportunity to improve the overall quality of life for their country's citizens. The need for these projects has been nationally recognized and accepted, however the citizens also acknowledge the natural beauty and the unspoiled environment of their country needs to be maintained for future generations. They want progress and improvements to their quality of life without the loss of unique and/or critical habitat and appreciate the value their nation's contribution to the world's environmental landscape is critical to the overall success and prosperity of their country.

Generally these projects are very complex, cover large geographical areas, and are typically at the broad system level scale. Types of large scale national projects include potable water supply systems, wastewater systems, flood and storm water damage reduction systems, land/water/air transportation systems, economic and communication systems, national defense and security systems, natural and terrorist emergency response systems, and sustainable ecological environmental systems. Funding for the development of these systems would be partly provided by the host nation, secured through loans from the world bank and/or have been offered by loans from individual countries and/or investment groups throughout the world.

Employee development programs in USACE will need to be expanded to include foreign language and foreign cultural skill sets to ensure a workforce capable of seamlessly interacting with any specific host country.

U.S. Army Engineer Institute for Water Resources

The Institute for Water Resources (IWR) is a Corps of Engineers Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA and Davis, CA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the Corps water resources planning and water management programs.

IWR strives to improve the performance of the Corps water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading Corps participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the Corps expertise center for integrated water resources planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

IWR provides managerial and technical support to the Civil Works Planning Community of Practice (CoP) in its execution of the Planning Excellence Program. This includes the management of the Planning Associates (PA) program, which is aimed to groom planning leaders capable of managing complex planning studies that lead to quality decision documents and who will provide water resources technical and professional leadership in the future. IWR also provides support to the local delivery of Planning Core Curriculum courses by the Corps MSCs. These seven courses provide the basic, full-performance training needed by entry level planners across the USACE as the means to accelerate their progress to the journeyman stage of their career development. These courses include: Civil Works Orientation, Planning Principles and Procedures, Environmental Considerations, Economic Analysis, H&H Considerations, Plan Formulation and Public Involvement and Team Planning.

In addition to the Planning CoP, the Institute plays a prominent role in the Economics CoP. The Corps Chief Economist is resident at the Institute, along with a critical mass of economists, sociologists and geographers specializing in water and natural resources investment decision support analysis and multi-criteria tradeoff techniques.

For further information on the Institute's activities associated with the Corps Economics Community of Practice (CoP) please contact Chief Economist, Dr. David Moser, at 703-428-6289, or via-mail at: david.a.moser@usace.army.mil. The IWR contact for the Corps Planning CoP activities is Ms. Lillian Almodovar at 703-428-6021, or: lillian.almodovar@usace.army.mil.

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